

Restoration of Dry Forest Communities on the South Zone of the Cherokee National Forest

Programmatic Environmental Assessment





For More Information Contact:

Cherokee National Forest
Ocoee/Hiwassee District Ranger Michael Wright

3171 Hwy 64, Benton, TN 37307

Phone: 423-338-3300

Fax 423-338-3309

Michael.wright@usda.gov

OR

Tellico Ranger District Ranger Stephanie Bland 250 Ranger Station Road, Tellico Plains, TN 37385

Phone 423-253-8400

Fax: 423-253-2804

Stephanie.bland@ usda.gov

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

Contents

Contents	1
Introduction	1
Background	1
Project Location	2
Need for the Proposal	4
Consistency with the Cherokee National Forest Revised Land and Resource Management	
Nature of the Decision to be Made	
Public Issues	
Proposed Action and Alternative.	
Proposed Action	
Design Elements	
Alternative Considered but Eliminated from Detailed Study	
Environmental Impacts	
Issues	
Impacts	
Agencies or Persons Consulted	
Literature Cited	
APPENDIX 1: Dry Forest Community Descriptions	
APPENDIX 2: Restoration Plan Criteria	
APPENDIX 3 - Scenery Treatment Guide - Southern Regional National Forests	
Tables	
Table 1. Crosswalk to Forest Types	
Table 2. Proposed Silvicultural Treatments to be used to Achieve Restoration Goals	
Table 3. Intensity, context, duration, and context of likely change for mechanical harvest	
Table 4. Intensity, context, duration, and significance of likely change for prescribed fire	
Table 5. Intensity, context, duration, and significance of likely change for herbicide use	
Table 6: Long Term Cumulative Impacts on each Soil Indicator for Proposed Action	38
Table 7. Summary of maximum potential mechanized treatment acres, temporary road	
construction, associated disturbed soil area, and total watershed impervious area (TIA)	
Table 8. Effects Determinations	
Table 9. Management Indicator Species and Associated Purpose	
Table 10. Summary of Regional Forest Sensitive Species Effects	
Table 11. Viability Concern Species With Known Occurrences in Representative Habitat	48
Figures	
Figure 1. Vicinity map	2
Figure 2. Potential Restoration Areas	

This page intentionally left blank

Introduction

This Environmental Assessment is intended as a programmatic approach to accomplishing ecological restoration within four broadly defined, dry forest communities on the south zone of the Cherokee National Forest.

Background

Intensive historical land use since the time of European settlement are reflected in the existing condition of the forested landscape on the Cherokee National Forest. Thus, the resulting landscape is one with many plant communities supporting uncharacteristic "off-site" species. "Off-site species" is a term that is used to describe the occurrence of plant species in landscape positions and habitats where they would not be found under natural conditions. Forested stands with a proliferation of off-site species are often referred to as "departed" from natural condition. Goal 17 of the Revised Land and Resource Management Plan for the Cherokee National Forest speaks to this condition and states "Restore and maintain forest communities to those plant communities predicted as most likely to occur based on the ecological potential of the site potential natural vegetation."

In 2017, the Cherokee National Forest South Zone Collaborative was convened by the Tennessee Chapter of The Nature Conservancy for the purposes of developing a set of restoration recommendations for off-site white pine. Through the discussions of the collaborative group, a more holistic understanding of the overall context of this type of restoration was reached, and the focus widened to include similar off-site species where restoration was needed. The group agreed to focus the scope of the recommendations primarily on two off-site pine species: white pine (*Pinus strobus*) and Virginia pine (*Pinus virginiana*) and their occurrence within four broadly defined, dry forest communities on the south zone: Shortleaf Pine-Oak Forest, Pine-Oak Heath Woodland, Dry-Mesic Oak-Hickory Forest, and Dry Oak-Heath Forest and Woodland. A crosswalk for these communities back to the Forest Service "Forest Types" is provided in Table 1 below. (See Appendix 1 for community type descriptions).

Table 1. Crosswalk to Forest Types

Dry Forest Community Type	NatureServe Sub-Type	Forest Service "Forest Type"	
Shortleaf Pine-Oak Forest	Southern Appalachian Low	12 – Shortleaf Pine – Oak	
	Elevation Pine Forest	16 – Virginia Pine – Oak	
		31 – Loblolly Pine	
		32 – Shortleaf Pine	
		33 – Virginia Pine.	
		44 – Southern Red Oak – Yellow	
		Pine	
Pine-Oak Heath Woodland	Southern Appalachian	15 – Pitch Pine Oak	
	Montane Pine Forest	20 – Table Mountain Pine –	
		Hardwoods	
		38 – Pitch Pine	
		39 – Table Mountain Pine.	
Dry-Mesic Oak-Hickory Forest	Southern Appalachian Oak	10 – White Pine Upland	
	Forest	Hardwood	
		13 – Loblolly Pine – Hardwood	
		42 – Upland Hardwoods – White	
		Pine	
		46 – Bottomland Hardwood –	
		Yellow Pine	
		47 – White Oak – Black Oak –	
		Yellow Pine	
		52 – Chestnut Oak	
		54 – White Oak	
Dry Oak-Heath Forest and	Allegheny-Cumberland Dry	45 - Chestnut Oak, Scarlet Oak	
Woodland	Oak Forest and Woodland	Yellow Pine	
		60 – Chestnut Oak – Scarlet oak	
		88 – Black Locust	

Project Location

The project area is spread across the south zone of the Cherokee National Forest comprised of both the Ocoee/Hiwassee and Tellico Ranger Districts as shown in Figure 1.

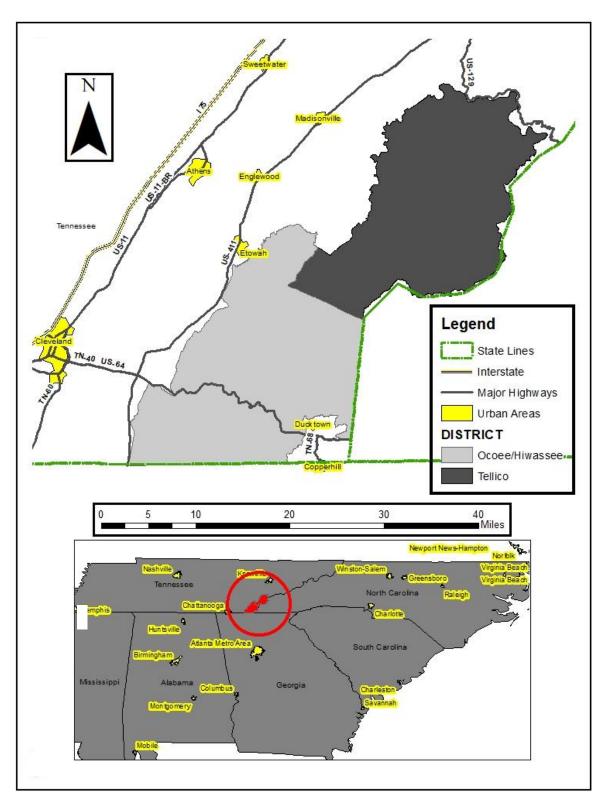


Figure 1. Vicinity map

Need for the Proposal

The purpose of this proposal is to address restoration goals and objectives from the RLRMP as they apply to the dry forest communities of the south zone. These plant communities, Shortleaf Pine-Oak Forest, Pine-Oak Heath Woodland, Dry-Mesic Oak-Hickory Forest, and Dry Oak-Heath Forest and Woodland are defined in the final report from the south zone collaborative (The Nature Conservancy 2018). Modeling for occurrence of these communities on the landscape was completed using the "Ecological Zones on the Chattahoochee and Cherokee (south) National Forest: 1st Approximation" (Simon 2016).

Areas in need of restoration were determined by overlaying the mapped communities with RLRMP management prescription areas and various management sideboards. Therefore, at least 62,000 acres of these communities (within the 300,000 acre project area) have been modeled on the south zone. These communities represent a large area where potential landscape scale restoration could occur (Figure 2).

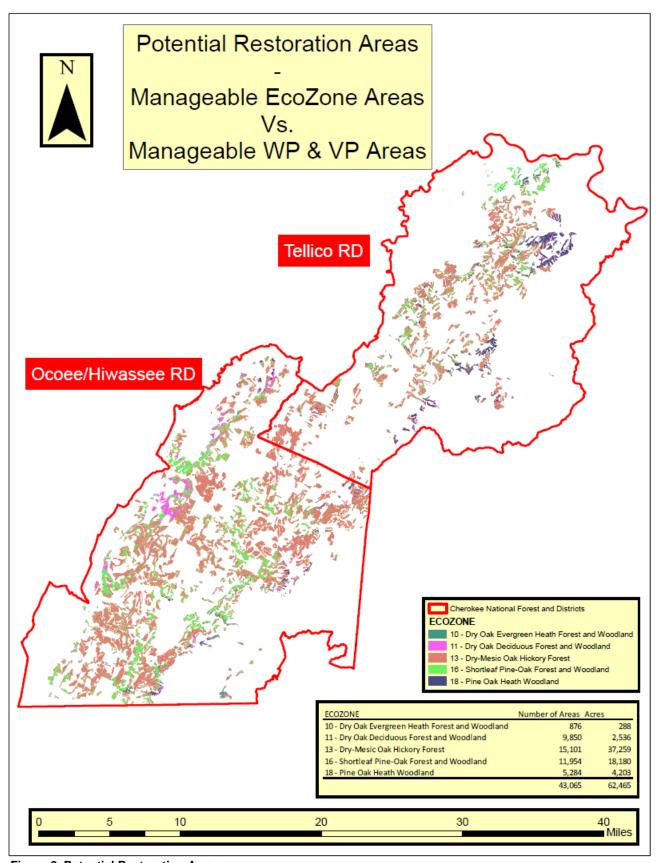


Figure 2. Potential Restoration Areas

In order to be considered as a site for site-specific restoration actions, current conditions would be compared to the desired condition. Within the four dry forest types, the current condition of forested stands would be evaluated using the following two conditions:

<u>Dominant off-site pine</u>: Off-site pine species represent the dominant species in the canopy, regardless of age or size.

<u>Encroaching off-site pine</u>: Off-site pine species are not the dominant trees within the stand, but have encroached where they would not naturally occur.

- Off-site pines are in the understory of a stand that is dominated by shortleaf, pitch, or table mountain pine, or hardwoods.
- Off-site pines are in the mid-story of a stand that is dominated by shortleaf, pitch, or table mountain pine, or hardwoods.

At the landscape scale, the use of ecological zone mapping tool (Simon 2016) provides a good approximation. The modeling uses multiple environmental and ecological parameters to predict the natural vegetative communities at a landscape scale. This is an excellent tool for planning at the landscape scale, however, it is not intended to be prescriptive and is not a substitute for site or stand scale assessments. The ecozone data is best used for assessing ecological potential and landscape scale priorities.

At the stand or site scale, site specific information would be used to refine the desired condition. This refinement would be based on field observations by qualified staff looking at the advanced regeneration of desirable species, the presence of stumps, the evidence of past fires, and remnant or relic trees within the stand or adjacent stands, among other indicators of the natural forest condition.

If no management action is taken and off-site vegetation (primarily white pine and Virginia pine) continues to expand into habitats where they are not ecologically appropriate, the desired species composition of these communities would continue to decline. With the decline, resiliency to disturbances including insect and disease, fire, and variations in climate would be reduced making this dry forest community more vulnerable to a wide array of stressors. The proliferation of white and Virginia pine and is potentially affecting other resources, including many wildlife species that depend on natural plant communities.

At the landscape scale, the desired condition is to promote the growth and regeneration of native species including shortleaf pine oak, in order to move towards a resilient and healthy ecosystem that includes species that are at or moving towards their ecological potential (Simone 2016). There is a need to remove off-site pine seed sources in order to prevent further encroachment from undesired species.

At the local (stand) scale, the desired ecological condition includes advanced regeneration of desired species by designing treatments that considers natural condition evidence including the presence of stumps, past fires, remnant or relic trees (TNC 2018, p. 8).

Natural fire has been suppressed for decades in many dry forest communities. There is a need to re-establish the use of fire in this fire-adapted landscape to restore and maintain native plant communities. The use of fire and monitoring vegetative response can be a useful tool in achieving the desired condition of these dry forest communities

In order to move towards ecological desired conditions there is a need for a complete suite of management tools (mechanical, chemical, prescribed fire) to be available to address the variety of conditions that occur across the landscape, including the need for adequate access to potential treatment areas.

Consistency with the Cherokee National Forest Revised Land and Resource Management Plan

Restoring or moving towards desired conditions in the dry forest community type would meet several goals in the Cherokee National Forest Revised Land and Resource Management Plan (RLRMP) which focus on maintaining and restoring forest communities (Goal 17,10), native tree species (Goal 18), and ecological sustainability within fire-adapted communities (Goal 18, 21)

Nature of the Decision to be Made

Unlike other analyses that result in a decision that implements specific actions on the ground, this proposal is programmatic in nature. This means this analysis and decision will identify ecological desired conditions, proposes a suite of actions that could be taken when various conditions exist within a stand, and identify additional criteria or design elements that should be applied to specific actions. This decision will provide general environmental consequences that result from treating the landscape over time. The decision will include a restoration criteria guide that identifies details on how to move towards desired conditions.

This decision will not authorize a site-specific (ground-disturbing) action that can be implemented. Additional environmental analyses (environmental assessments or categorical exclusions) that tier to and incorporate by reference this programmatic analysis would need to be developed and a new decision(s) issued prior to any implementation. This approach is consistent with the 2014 guidance provided by the Council of Environmental Quality (CEQ 2014).

Inherent within a programmatic EA approach is the assurance that necessary site specific surveys would be conducted within forested stands proposed for treatment, to avoid, minimize or mitigate impacts to cultural or archeological resources; threatened, endangered, or sensitive species; steep slopes and erodible soils; scenic values; and potential for the spread of invasive species.

Public Issues

Scoping to solicit the issues and concerns related to the Proposed Action started in February 2019. Letters (see Project Record) were mailed to approximately 70 interested or potentially affected agencies, organizations, tribes, and individuals (see Consultation and Coordination section). These letters informed recipients of the Proposed Action and requested their input. The proposal has also been listed in the Cherokee National Forest Schedule of Proposed Actions from January 2019 through the present. In addition, all letters requesting public input have been placed on the Cherokee National Forest web page along with a narrative of the proposal.

Issues were derived from the comments received from the scoping request and Forest Service resource specialists. Issues are defined as a point of discussion, debate, or dispute about

environmental effects. These issues are the basis for the project analysis, project design elements, alternatives, and overall disclosure of information in this document and supporting documentation found in the project record.

The comments were reviewed and separated the issues into two groups: issues to be analyzed and issues considered but not carried forward in the analysis. Issues considered but not carried forward are identified as those: 1) outside the scope of the Proposed Action; 2) already decided by law, regulation, RLRMP, or other higher level decision; 3) irrelevant to the decision to be made; or 4) conjectural and not supported by scientific or factual evidence. The Council for Environmental Quality (CEQ) NEPA regulations require this delineation in Sec. 1501.7, "...identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)..."

A list of issues considered but not analyzed and reasons regarding their categorization are included in the project record at the Tellico Ranger District. Issues that were raised about the effect of activities on trails and trail users are addressed by following standard procedures (i.e. Forest Service Handbook (FSH) 2309.18, contract clauses, and RLRMP standards (FW: 72-84 and 87 specifically for herbicide treatments).

Issues to be analyzed are derived from the comments received from the public and by the ID Team:

- What effect will the proposed action have on dry forested communities to change the composition, structure, and diversity to the desired condition? A component of the vegetation issue is: Will desired species that are a minor component of the forest stands be adversely affected by the proposed activities?
- There are concerns about the effects the proposed activities would have to soil quality, soil productivity, and soil ecosystem services. A component of the soil issue is: Is there a slope percentage on which activities should be limited.
- There are concerns about the effects of proposed activities to legally designated beneficial uses of water resources and effects to channel morphology and aquatic habitats.

Proposed Action and Alternative

Proposed Action

In response to the purpose and need, the following actions may occur over a period of at least 10 years on approximately 62,000 acres of dry forest community vegetation once an action has been assessed site-specifically and in accordance with the restoration plan criteria:

- ➤ Utilize a suite of silvicultural activities including both commercial and non-commercial vegetation treatments and site preparation for natural vegetation regeneration and planting (Table 2).
- ➤ Utilize prescribed fire to create and maintain desired conditions and the use of fire to enhance the success of regeneration on sites that require planting. In situations where the off-site pines are encroaching into the understory of an otherwise diverse and characteristic dry forest community, preference should be given to the use of prescribed fire. Fire would be used at its ecologically appropriate intensity, duration, frequency and

- spatial extent. Containment lines would be preferentially determined using existing roads, streams, and other natural and man-made features to minimize additional ground disturbance (dozer lines).
- ➤ Utilize herbicides for restoration purposes that are for a targeted species and are applied in a targeted manner. Herbicide use is most beneficial where prescribed fire or mechanical treatments alone cannot meet the desired objective. It may also be beneficial in conjunction with other treatments. A suite of herbicides would be used to prepare or manage a site that has been treated to remove "offsite pine species" and promote desirable native species composition.
- All herbicides and surfactants would be used in accordance with label requirements and RLRMP standards. Chemical treatments could include streamline basal bark, hack and squirt, cut stem surface, or foliar spray methodologies. Active ingredients that been approved for Forest Service use include but are not limited to glyphosate, triclopyr, and imazapyr.
- ➤ To provide adequate access to treatments, conduct reconstruction on national forest system roads. Temporary roads [Forest Service Manual (FSM) 7700, zero code] would be constructed as necessary.

Table 2. Proposed Silvicultural Treatments to be used to Achieve Restoration Goals

Treatment Type	Tree Retention	Description of Activity
Stand Clearcut	0 BA/A	An even-aged regeneration or harvest method that removes all trees in the stand producing a fully exposed microclimate for the development of a new age class in one entry.
Seedtree Preparatory Cut	80% total BA/A	An optional cut to enhance conditions for seed production and/or develop wind-firmness for a future seedtree establishment cut.
Seedtree Establishment Cut	10-20 BA/A	A type of cut that removes trees except those needed for the purpose of seed production. Prepares the seed bed and creates a new age class in a moderated microenvironment. Additional trees may be retained to provide a minor (less than approximately 10% of full stocking) live component after the removal cut, for reasons other than regeneration.
Seedtree Final Cut	0-10 BA/A	A final removal cut that releases established regeneration from competition with the overwood after it is no longer needed for seed under the Seedtree regeneration method.
Commercial Thinning	40-80 BA/A	An intermediate harvest with the objective of reducing stand density primarily to improve growth, enhance forest health, and other resources objectives. Treatment can recover potential mortality while producing merchantable material.
Pre-commercial Thinning	60-100 BA/A	The cutting of trees not for immediate financial return but to reduce stocking.

Table 2. Proposed Silvicultural Treatments to be used to Achieve Restoration Goals

Prescribed Burn	Site	Use of Rx fire for ecological restoration	
	Specific		
Site Preparation for I	Planting		
Manual	Site Specific	Manipulation of a site using manual methods (chainsaw machetes, etc.) to enhance the success of regeneration of sites that will be planted.	
Chemical	Site Specific	Manipulation of a site using chemical methods (listed in herbicide use recommendations above) to enhance the success of regeneration on sites that will be planted.	
Burn	Site Specific	Manipulation of a site by prescribed burning to enhance the success of regeneration on sites that will be planted.	
Site Preparation for N	Natural Regen	eration	
Manual	Site Specific	Manipulation of a site by using manual methods (chainsaws, machetes, etc.) to enhance the success of natural regeneration	
Chemical	Site Specific	Manipulation of a site by using chemical methods (listed in herbicide use recommendations above) to enhance the success of natural regeneration	
Burn	Site Specific	Manipulation of a site by prescribed burning to enhance the success of natural regeneration	
Additional Activities			
Plant Trees	Site Specific	The establishment or re-establishment of forest cover artificially by planting seedlings and/or cuttings with or without site preparation.	
Tree Release and Weed	Site Specific	A treatment designed to free young trees from undesirable, competing vegetation. Incudes cleaning and weeding which are done in stands not past sapling stage.	
Improvement Cut	Site Specific	An intermediate harvest which removes the less desirable trees of any species in a stand of poles or larger trees, primarily to improve the composition and quality.	

Design Elements

RLRMP standards and soil and water best management practices (Forest Service and Tennessee Division of Forestry) would be required and their use has been a key assumption used in the environmental analysis (see project record). In addition to these standard requirements, the following design elements would apply in the dry forest cover type:

Roads

Temporary roads would be limited to 1/2 mile each for each unit. After use, all temp roads would be managed following RLRMP standards and state BMP's. (The road prism would likely remain on the landscape until such a time as site specific analysis suggests otherwise)

Any temporary road constructed in an area identified in the *Tennessee Mountain Treasures* (Irwin 1996) beyond ½ mile would be re-contoured. These areas are not given any special designation in the RLRMP.

Skid trails and temporary roads for the purpose of timber harvest would not be constructed for sustained distances over 200 feet in areas with slopes of 40% or greater ("steep area"). The 200-foot length can be exceeded however where the skid trail and/or temporary road is needed to traverse a steep area in order to access the remaining harvest unit(s).

Reconstruction of National Forest System Roads would be allowed unless it changes the road management objective.

Soil

Ground based mechanical treatments on slopes equal to or less than 35% will be covered by this programmatic analysis. Operations on slopes greater than 35% should be considered a special circumstance and will require additional, site specific analysis.

During survival checks, the timber staff also evaluates the effectiveness of BMP implementation on skid roads, landings, and temporary haul roads. If deficiencies are found, they are addressed with appropriate corrective measures which may include the following: seed, straw, fertilizer, mulch, matting, slash, tops, and others.

Different seed mixes are used depending on soil type, steepness, time of year, and other factors. Generally, annual grains are used.

Unacceptable ruts created on skid roads or log landings during harvesting operations are smoothed out, water is diverted appropriately, and erosion is thusly limited.

If rutting occurs within the unit (off of skid trails), operations are halted by the sale administrator until soil moisture conditions improve.

Ground cover shall be applied to all bladed areas with greater than 12% slope on any of the SOC map units as part of erosion control. Ground cover, may include mulch, logging slash, natural leaf-fall, etc. These areas would also have drainage controls installed before closure.

Fire Lines

Remove or reduce thinning slash within up to 100 feet of prescribed burn dozer lines or hand lines, dependent upon line type and topographical considerations such as whether a line is mid-slope or on flat ground

Fell trees away from roads slated to be utilized as prescribed burn lines.

Activity fuels should also be slashed down to less than 2 feet above ground level to create a buffer zone of reduced fire behavior within up to 100 feet of roads utilized as prescribed burn lines.

Remove or reduce thinning slash within up to 100 feet of private property boundaries,

Mid-slope line should be avoided due to fire spotting and firebrand rollout concerns; ridgetops or drainage bottoms are preferred line locations.

Non-native Invasive Plant Species

Inventory for non-native invasive plant species in and around proposed projects before initiating

ground disturbing activities or burning.

When found, treat infestations of species that have the ability to spread rapidly either vegetatively or through seed, or that are known to increase with fire.

Require that heavy equipment be washed and weed-free before being brought to the forest (Contract Clause BT6.35)

If known that work will occur in both weed-free and weed infested areas, work in weed-free sites first to minimize potential movement on equipment and vehicles.

Include identification/detection of weed species in post burn monitoring.

Revegetate disturbed areas with locally adapted native species when appropriate.

Aquatic Species

Streamside filter zone extended to 300 feet on either side for all threatened, endangered or proposed species (T&E) critical habitat and occupied habitat. Additionally tributaries that feed into critical/occupied habitat also buffered by 300 feet on either side extending from the confluence of the affected habitat, upstream one half mile

The activities restricted in the aquatic T&E extended buffer zone: road construction, mechanical vegetation treatments, skid trails, log landings, bladed or hand firelines, and prescribed fire.

Indiana and Northern long-eared bats

The January 2015 Indiana Bat Biological Opinion (BO) contains Reasonable and Prudent Measures and Terms and Conditions that are part of the Proposed Action. The January 2016 Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities Excepted from Take Prohibitions is part of the Proposed Action.

Trails and Recreation

Where needed, vegetation or woody materials will be retained or deposited to inhibit creation of undesired routes used by visitors or to protect/screen sensitive resources.

During the planning stage of vegetation treatment work or projects, consult with the Forest Recreation Manager and District Recreation Manager where treatment work may occur in recreation sites or along trails to ensure that recreation management objectives and standards are met in the Cherokee National Forest RLRMP, FSH 2309.18 (Trails Management Handbook), FSH 2309.13 (Planning and Design of Developed Recreation Sites and Facilities), and FSM 2330 (Publicly Managed Recreation Opportunities).

If Forest Service System trails or Forest Service recreation sites are damaged during treatment work, the trail or recreation site will be restored to Forest Service required specifications and standards in FSH 2309.18 (Trails Management Handbook), FSH 2309.13 (Planning and Design of Developed Recreation Sites and Facilities), and FSM 2330 (Publicly Managed Recreation Opportunities).

Design elements in Appendix 3, "Scenery Treatment Guide - Southern Regional National Forests," would be implemented as practicable in project design to achieve the appropriate levels of scenic integrity as described in the RLRMP.

Monitoring

In order to ensure that each restoration project is successful, the following monitoring should be included in subsequent site specific proposals:

1. Clear goals and measurable objectives for achieving ecosystem structure and composition.

2. Project level monitoring to measure whether, and to what extent, those objectives are achieved.

Restoration Plan Criteria

This restoration plan criteria is intended to be a "roadmap" to moving towards desired conditions. It provides the criteria and a decision tree when assessing a need for treatment. See Appendix 2, for the Restoration Plan Criteria.

Alternatives Considered but Eliminated from Detailed Study

Following guidance under 36 CFR 220.7(b)(2) this environmental assessment addresses only those alternatives that meet the need for action. Per these regulations, the no-action alternative is addressed through effects analysis by contrasting the impacts of the proposed action with the current condition and expected future condition if the proposed action were not implemented. The proposed action and those issues that were identified through internal and external scoping are addressed within the EA, and no additional issues were presented that would lead to another alternative.

220.7 Environmental assessment and decision notice

- 220.7(b)(2) Proposed action and alternative(s). The EA shall briefly describe the proposed action and alternative(s) that meet the need for action. No specific number of alternatives is required or prescribed.
 - (i) When there are no unresolved conflicts concerning alternative uses of available resources (NEPA, section 102(2)(E), the EA need only analyze the proposed action and proceed without consideration of additional alternatives.
 - (ii) The EA may document consideration of a no-action alternative through the
 effects analysis by contrasting the impacts of the proposed action and any
 alternatives(s) with the current condition and expected future condition if the
 proposed action were not implemented.

In many cases a "no action" alternative simply describes what would occur in the absence of any new management, but it useful here to highlight the fact that the proposed action is much more than a continuation of a "business as usual" approach. The current condition of dry forest communities on the Cherokee National Forest is a direct result of existing limitations to management, and the purpose of this programmatic decision document is to facilitate the implementation of Forest Plan restoration objectives and the accomplishment of high-priority restoration work in a manner that is both consistent with the Forest Plan and at a higher rate than has been accomplished in the past.

The following alternative was considered but eliminated from detailed study.

Treatment of White Pine Only

An alternative to consider only the effects of off-site white pine was considered initially by the collaborative group and Forest Service. White pine is very sensitive to fire, and thus is a natural component of the ecosystem primarily in cool, moist sites such as riparian areas and north-facing slopes where natural fire rarely plays a role. It becomes "off-site" when it spreads into dry forest communities in which fire has been suppressed. Virginia pine is likewise quite sensitive to fire effects, thus the two species often are found together encroaching into dry forest communities.

Because Virginia pine is an aggressive seeder, and capable of rapid growth, an attempt at ecological restoration that only addresses white pine without removing Virginia pine from the same or adjacent areas, would only exacerbate the problem with Virginia pine on the landscape. Because both of these species lead to the degradation of biodiversity within dry forest communities addressing only one of them would not be a holistic approach and would not meet the purpose and need of ecological restoration.

Environmental Impacts

Issues

This section includes the issues that have been identified for detailed analysis because the impacts of the Proposed Action may be related to potential significance or the ability to meet the need of the project. The following issues were identified and analyzed to determine the potential for significance:

- What effect will the proposed action have on dry forested communities to change the composition, structure, and diversity to the desired condition? A component of the vegetation issue is: Will desired species that are a minor component of the forest stands be adversely affected by the proposed activities?
- There are concerns about the effects the proposed activities would have to soil quality, soil productivity, and soil ecosystem services. A component of the soil issue is: Is there a slope percentage on which activities should be limited.
- There are concerns about the effects of proposed activities to legally designated beneficial uses of water resources and effects to channel morphology and aquatic habitats.

Impacts

Proposed Action

This section discloses the environmental impacts of the Proposed Action.

When considering cumulative effects of implementing the Proposed Action the following activities were included but not limited to: prescribed fire, natural disasters (wildfire, tornado etc.) recreational uses (i.e. camping, hiking, hunting, fishing, scenic driving, etc.); utility right-of-way (ROW) and road maintenance; non-native invasive species treatments; illegal OHV use; impacts from insects and diseases, timber harvesting, and private land use patterns.

Vegetation

Historic land acquisition maps of the southern Appalachians and Cherokee National Forest show a general pattern of natural plant community distribution on the landscape, with xeric pine and other dry forest communities found along the ridges and south facing slopes, transitioning to larger, more productive hardwood sites along rich, northern facing slopes and coves. While this pattern still exists on the Cherokee National Forest, the species composition of these dry forest communities is not so clear. Changes due to intensive land use and sequential impacts from insects and disease, climate events, and fire prevention have left eastern forests in a successional flux which has caused some species to expand well beyond their natural distribution while others

have seen dramatic declines (USDA 2012, Elliot et al. 2009, Abrams 2005, Vose 2004, NatureServe 2002, USDA 2001, SAMAB 1996, Arthur, et al. 1998, Harmon 1982).

Based upon what is known about the natural (historic) distribution of these communities across the southern Appalachian region and the effect of historic and present land use upon them, it is likely that the current acreage of pine dominated communities is more expansive (Lynch and Clark 2002, Harmon 1982) but the species composition less fire tolerant (NatureServe 2002, Stanturf et al. 2002, Lynch and Clark 2002, DeSelm and Clebsch 1990). This is primarily due to the extensive clearing and burning of southern Appalachian forests during early settlement, with the subsequent planting of pine species, and then decades of fire suppression on the landscape. Thus species like Virginia pine and white pine have increased their aerial extent at the expense of the more fire tolerant southern yellow pines such as shortleaf pine, pitch pine, and Table Mountain pine (Ayres and Ashe 1905, USDA 2004, NatureServe 2002).

Over 62,000 acres of dry forest communities have been identified as being potentially affected by off-site pine species on the south zone of the Cherokee National Forest, representing a large potential for ecological restoration (Figure 2 & Appendix 1). A full suite of silvicultural methods including the use of prescribed fire and herbicides are proposed as tools to restore affected communities on the landscape (Table 2). Due to the programmatic nature of this assessment, no specific sites are identified for restoration treatments in this document, however a restoration framework and decision tree are provided in Appendix 2 as the "Restoration Plan Criteria" that will be used to guide future site specific actions and decisions that will tier to this analysis. General and indirect effects of the Proposed Action and the cumulative impacts of the Proposed Action plus other ongoing and foreseeable actions are discussed below.

General and Indirect Effects

Silvicultural activities including both commercial and non-commercial vegetation treatments and site preparation for natural vegetation regeneration and planting, are designed to have a long-term beneficial effect on the overall composition and structure of dry forest communities. If no management action is taken and off-site vegetation continues to expand into habitats where they are not ecologically appropriate, the desired species composition of these communities will continue to decline. With the decline, resiliency to disturbances including insect and disease, fire, and variations in climate will be reduced making this dry forest community more vulnerable to a wide array of stressors. The proliferation of white and Virginia pine and is potentially affecting other resources, including many wildlife species that depend on natural plant communities.

Restoration criteria listed in Appendix 2 state that proposed activities in any given forested stand should be designed to preserve and promote biodiversity. Whenever possible, leave trees should include a full range of the native tree diversity appropriate to the site, as species diversity of the future stand should be of paramount importance. Descriptions of desired future conditions (DFC) for each dry forest community are provided in Appendix 1. Current conditions on the landscape vary from highly departed (communities dominated by off-site pine species in the canopy or other strata) to fairly intact natural communities with varying levels of encroachment into the understory or midstory.







Dense Virginia pine stand occupying dry ridge.

Dry forest dominated by pole sized white pine.

Encroaching white pine being managed with Rx fire.

Based upon the existing conditions found on the landscape, a variety of silvicultural techniques can be used both singly, and in combination, to move a stand towards the DFC. The effects of various harvesting techniques (clear cut, seed-tree, thinning, etc.) and site preparation methodologies have been well documented in the literature (Smith et al. 1997, Hicks 1998, Nyland 2002, Johnson et al. 2009) and are only briefly described here.

Clearcutting would be used in the context of restoration to convert a forested stand that is dominated by off-site species in the canopy to one that will support the DFC. Clearcutting directly affects the amount of sunlight exposure to the forest floor and provides an influx of released nutrients from the logging slash, which often stimulates rapid germination and growth from the seedbank. This new growth often includes a suite of undesirable species and can include non-native invasive species if there is a seed source in the area. Thus, while this treatment provides an opportunity to optimize the success of planting species that are advantageous to the site, it also requires an array of follow up treatments to control non-desired species, including site preparation burns, manual or chemical weeding and release, and prescribed fire.

Like clearcutting, the use of seed tree, thinning treatments, and improvement cuts listed in Table 2 would be utilized based upon the existing condition of a stand. Each technique is suited to differing stand condition, and their use would be determined at the site specific level to best achieve restoration goals (see Appendix 2). While clearcutting relies on artificial regeneration (planting of seedlings) to ensure the desired composition the future stand is achieved, seed tree cuts rely on natural regeneration from the species that were selectively left in the stand. As with clearcutting though, general effects of all these treatments would include varying levels of increased light, nutrient release, and amount of slash left on the ground. It is important to note that none of these treatments should be considered as the sole action to reach the DFC, but rather, a variety of follow-up treatments will be needed. Follow-up treatments for these harvest types are similar to those described above and are primarily designed to keep the trajectory of the emerging stand moving toward the DFC.

Potential indirect effects to other resources (soil and water, wildlife, recreation, etc.) from silvicultural treatments are described in other sections of this document. Indirect effects specific to the vegetative component of dry forest communities can include the build-up of hazardous fuels and the potential establishment and spread of non-native invasive species. For additional background info on prescribed fire and fuels, see the specialist report on fuels in the project file

A qualitative assessment of fuel loadings and the consequences to future fire activity was used as the indicator for effects to fuels. Fuel loadings that would be produced by the proposed actions are too variable to quantify and analyze at the programmatic level. Site-specific data would be needed to model fuel loadings and potential fire behavior. Therefore, a comparison of relative fuel loadings and subsequent fire outcomes is based on a qualitative assessment of fuels.

Commercial and pre-commercial thinning treatments, seed tree cuts, and clear cuts would increase both fine and coarse woody fuel loadings on the ground to varying degrees, which in turn would possibly increase fire intensity and severity on future prescribed burns or wildfires. In the event of a fire, fine fuels determine the rate of fire spread and intensity for an initiating surface fire. Coarse fuels have little influence on fire spread and intensity, but they can contribute to the development of large fires and increased fire severity (Brown et al. 2003).

Additional activities such as site preparation for natural vegetation regeneration and planting may include manual or chemical site manipulation to reduce competing vegetation. These types of site preparation would increase the fuel loading once the targeted vegetation accumulates on the forest floor, although this would occur to a far lesser degree than other commercial and precommercial treatments. Site preparation utilizing prescribed burning would consume fine fuels, thus decreasing fine fuel loadings.

Activity fuels may accumulate near proposed or current prescribed burn unit lines, creating difficulty installing lines and keeping burns within unit boundaries during implementation. Mitigation measures designed to reduce these effects include removing or reducing thinning slash within up to 100 feet of prescribed burn dozer lines or hand lines, dependent upon line type and topographical considerations such as whether a line is mid-slope or on flat ground. This could be accomplished with methods such as directional felling, moving and scattering cut material away from constructed fire lines, or changing the fuel structure from vertical to a horizontal layer of chips through mastication. Additional mitigations include felling trees away from roads slated to be utilized as prescribed burn lines. Activity fuels should also be slashed down to less than 2 feet above ground level to create a buffer zone of reduced fire behavior within up to 100 feet of roads utilized as prescribed burn lines.

Activity fuels may also accumulate in the wildland-urban interface (WUI), defined as the area where humans and their developments meet or intermix with wildland fuels (NARA 2001). In the event of a wildfire, resistance to control would possibly be increased in areas of heavier fuel accumulations resulting from silvicultural treatments. Constructing fire line by hand could be more difficult due to the greater amount of fuels to cut and move as well as the higher levels of heat generated from the fire, and dozer line construction could also be slowed. Mitigations include removing or reducing thinning slash within up to 100 feet of private property boundaries, allowing a potential area to construct line in the event of a wildfire if topography and other conditions allow. This could be accomplished with methods such as directional felling, moving and scattering cut material away from constructed fire lines, or changing the fuel structure from vertical to a horizontal layer of chips through mastication.

Implementing these actions would mitigate the most commonly encountered fuel loading issues. Having a suite of mitigations allows flexibility to choose the appropriate course of action given a particular set of factors, including fire line types and topographical considerations. These mitigations have been developed for the landscape level, and further site-specific analysis may show a need for additional future mitigations.

Non-native invasive species are a pervasive problem on the Cherokee National Forest and are addressed through policy, law, and a variety of design criteria and other mitigations.

The Southern Appalachian Assessment (SAMAB 1996) provided a summary of the major threats to southern Appalachian forests from non-native invasive species and much of this information has been revised and updated in the Southern Forest Futures Project (USDA 2013).

Executive Order 13112 was issued in 1999, which states that federal agencies shall "not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species." Also in 1999, the Southern Region released a Noxious Weed Management Strategy that outlined five emphasis areas, 1) Prevention and Education, 2) Control, 3) Inventory, Mapping, and Monitoring, 4) Research, and 5) Administration and Planning. This was followed in 2001 with the development of the Regional Forester's Invasive Exotic Plant Species list for Region 8. The Cherokee National Forest RLRMP includes numerous Goals, Objectives, and Standards to address the potential impacts of non-native invasive species. These include control efforts and maintenance and restoration of native species.

On the south zone of the Cherokee National Forest there are several non-native invasive plant species that can rapidly invade dry forest communities as a result of disturbance. Tree of heaven (*Ailanthus altissima*), autumn olive (*Eleagnus umbellata*), sericea lespedeza (*Lespedeza cuneata*), bicolor lespedeza (*Lespedeza bicolor*), princess tree (*Paulownia tomentosa*), kudzu (*Pueraria montana*), and Japanese honeysuckle (*Lonicera japonica*) are the primary species of concern at this time. While many other non-native invasive plant species occur on the forest, these species are recognized as having substantial occurrences with a high potential for impacts to dry forest communities if left untreated. A thorough analysis of invasive plant species response to a variety of silvicultural practices is provided in Evans, et al (2006).

Potential introduction of new species and spread of existing non-native species through timber sale activities would be mitigated in part through the use of contract clause BT6.35 on any future site specific proposals. This clause is mandatory in all timber sale contracts and requires that equipment moved on to the forest has been cleaned and is free of "all seeds, soil, vegetative matter, and other debris that could contain or hold seeds" of invasive species. Treatment of nonnative invasive plant species is also occurring forest-wide on the basis of prioritized acres. If an infestation within the project area meets the criteria of highest priority acres for treatment as outlined in the forest-wide environmental assessment (USDA 2008) it would be treated accordingly. The southern Forest Futures Project (USDA 2013) provides projected annual rates of spread (absent control programs) for numerous high-priority invasive plant species in southern forests. These range from a low rate of an average of just over 50 acres per year across the southeast for Oriental bittersweet, to an average rate of over 60,000 acres per year for Japanese honeysuckle. The presence of non-native invasive species is documented during botanical surveys conducted for site specific proposals, and if identified, infestations can be treated prior to restoration activities to cut off seed production. Treatments would be made on a priority basis based upon the perceived risk of invasion and establishment into the managed stand. Species that are known to spread rapidly in one season (i.e. kudzu) or that produce wind-borne seed that can easily disperse into an area (i.e. princess tree and tree of heaven) would be of highest priority for treatment. Mitigations that are a part of this proposal (described in greater detail below under prescribed fire effects), and possible future treatments, should work together to slow the spread of these species.

Prescribed fire would be used to create and maintain desired conditions and reduce fuel loading that could result from silvicultural treatments. Prescribed fire can be a useful tool for ecological

restoration, when focused on effects to the understory composition. Dry forest communities in the southern Appalachian Mountains are often referred to as "fire adapted" as their species composition has been shaped somewhat over time by exposure to naturally occurring fire. Keeley et al. (2009) provide a good discussion of the terms "fire sensitive", "fire adapted", and "fire dependent", the latter referring to species or plant communities that require fire to perpetuate their life cycle. Species with fire adaptive traits have adapted to specific fire regimes over a long period of time (Frost 1998), thus they may tolerate some fire effects, and may even have an adaptive advantage over fire sensitive species, yet they don't require fire for reproduction. The response of a fire adapted species to prescribed fire will differ based upon the frequency and intensity at which fire is used. Based upon that, it is important that monitoring of results be a critical part of any restoration plan using prescribed fire.

Fire effects can be broken down into the physical, chemical, and biological impacts of fire on ecosystem resources and function. Physical and chemical effects of fire include its role in changing air quality, water quality, soil properties, and nutrient cycling. Biotic effects of fire include impacts to vegetation and wildlife. Most of those effects are described elsewhere in this document. General and indirect effects to vegetation are provided here.

Incorporating prescribed burning either as a stand-alone restoration treatment or for site preparation following tree removal, would result in lower overall fuel loadings than mechanical treatments such as thinning. Prescribed burning is conducted primarily during the dormant season in the spring and fall months when fuel, weather, and soil conditions permit a low to moderate intensity burn. Some areas may be burned at a higher intensity or during the growing season if deemed necessary to meet restoration objectives.

Prescribed burns reduce understory woody vegetation in the short term of 1-3 years and can stimulate the growth of grasses and other forbs (Elliott et al. 1999; Waldrop 2008). Low to moderate intensity burns primarily result in sapling and seedling mortality in the mid- and understory while having little effect on overstory trees (Elliott et al. 1999; Yaussy and Waldrop 2010). In white pine, a single prescribed fire has been shown to kill the majority of seedlings and saplings up to 1" diameter at breast height (DBH) (Blankenship and Arthur 1999; Drews and Fredericksen 2013). Little research has been conducted on fire effects in Virginia pine specifically, although two to three prescribed burn entries have been found to reduce the majority of all pine and hardwood saplings up to 4" DBH (Blankenship and Arthur 2006; Waldrop et al. 1992).

Prescribed burning allows more sunlight to reach the forest floor by reducing the mid-story vegetation, and it also reduces fine fuels in the litter layer. Both of these factors create an environment where re-sprouting and growth of new seedlings is prolific (Blankenship and Arthur 1999). As new growth increases in the understory, it contributes to the litter layer when the leaves and pine needles begin dropping to the ground. Fuel loadings are also increased as trees and other vegetation killed by prescribed burns fall and accumulate on the forest floor. Because fire is part of a natural disturbance regime that occurred in dry forest communities, but has been disrupted through fire suppression, continued prescribed burning may be necessary to maintain desired vegetation and fuel loading conditions on the landscape. The frequency of such burns would be determined through project level monitoring.

Within dry forest communities, different plant species exhibit a variety of specific "strategies" and morphological adaptations to fire. Some species like chestnut oak, are "resisters" to fire and

possess thick bark that can withstand scorching effects, or pitch pine that produces new "epicormic" sprouts from the stems. Other species like shortleaf pine and many woody shrubs are "endurers" that are often "top-killed" by fire, but re-sprout readily from a variety of modified morphological structures within the stems and roots (USDA 2000, p. 16). Many plants in the legume family are termed "evaders" in which the entire plant may be killed by fire, but it produces durable seeds that remain viable for a long time, and are often stimulated to germinate after fire. And finally, there are "invaders", plants like Virginia pine, white pine, and many weedy native or non-native invasive plant species. These species may be fire sensitive, but produce abundant wind-dispersed seed that readily germinates in open areas, and are poised to exploit openings that can be created in areas of high fire severity. How individual species respond to fire and become established on the landscape is thus based upon their specific adaptations, in combination with the intensity and duration of fire on the landscape. Through an understanding of fire effects on vegetation, and applying site appropriate firing techniques and fire frequency, prescribed fire can be an extremely useful tool used alone, or in combination with other silvicultural tools, to restore forests with off-site species to natural species assemblages.

When planning and implementing prescribed burns, certain factors should be considered for fire line designation and placement. Utilizing natural or pre-existing barriers to fire spread such as streams, rivers, and roads is preferred when designating burn unit boundaries. The higher humidity and riparian vegetation near streams and rivers are not conducive to fire spread, often resulting in a wider firebreak than the waterway itself when the fire is naturally extinguished before reaching it. Roads are a firebreak allowing desired access along a burn unit boundary for firing and patrolling. When it is not feasible to utilize natural or pre-existing barriers as fire lines, hand line or dozer line may be constructed for that purpose. Fire lines should be constructed where practitioners have a higher probability of successfully holding burns within unit boundaries. Mid-slope line should be avoided due to fire spotting and firebrand rollout concerns; ridgetops or drainage bottoms are preferred line locations.

Implementing these design criteria would mitigate common issues with prescribed burn unit layout. Utilizing the criteria in conjunction with the fuel loading mitigations listed in the silvicultural section would provide an overall framework for successful prescribed burn planning. Site-specific analysis for the most advantageous line designation, placement, and associated survey requirements would be conducted as future site specific proposals are developed.

As with silvicultural activities discussed above, non-native invasive plant can certainly become a problem in prescribed burn areas if ignored and left untreated. Brooks et al. (2004) discuss in detail how the presence of some non-native invasive plants can change fuel properties, which in turn affects fire behavior, and can ultimately alter fire regimes over time. The presence of invasive vines within a forest with otherwise light fuels can create ladder fuels that can turn a relatively low intensity surface fire into a crown fire under the right conditions. A few species in particular, are of concern on the south zone of the Cherokee National Forest in areas that have been impacted by fire or where fire will be prescribed. Princess tree (*Paulownia tomentosa*) and tree of heaven (*Ailanthus altissimus*) both produce large amounts of wind-borne seeds that can easily disperse into burned sites from adjacent areas. Shrubby lespedeza (*Lespedeza bicolor*) is a species that can sometimes be found in dense infestations along roads or trails that may be used as fire lines. While this species is typically does not invade intact forested sites, once a site is

opened up to greater light incidence through timber harvest or prescribed fire, this species has been documented to rapidly spread into those areas (Evans et al. 2006, USDA 2008b).







Princess tree infestation after severe wildfire.

Invasive vines can act as ladder fuels.

Shrubby lespedeza infestation along old logging

Specific mitigations to reduce the chance of spread and establishment of non-native invasive plant species that should be considered in future site specific projects include:

- Inventory for non-native invasive plant species in and around proposed projects before initiating ground disturbing activities or burning.
- When found, treat infestations of species that have the ability to spread rapidly either vegetatively or through seed, or that are known to increase with fire.
- Require that heavy equipment be washed and weed-free before being brought to the forest (Contract Clause BT6.35).
- If known that work will occur in both weed-free and weed infested areas, work in weed-free sites first to minimize potential movement on equipment and vehicles.
- Include identification/detection of weed species in post burn monitoring.
- Revegetate disturbed areas with locally adapted native species when appropriate.

The use of herbicides for restoration purposes would only be applied for targeted species in a targeted manner and would be in full compliance with all label restrictions and RLRMP standards (FW-72 through FW-84, and FW-87). Herbicides would be used to reduce the amount of competition from undesirable vegetation where it impedes the development of desired conditions. Chemical treatments would be used in conjunction with site preparation and weeding and release activities and could include streamline basal bark, hack and squirt, cut stem surface, or foliar spray methodologies. Streamline basal bark, hack and squirt, and cut stem surface treatments are all precise applications that put the herbicide directly on to the target plant surface with little to no chance of non-target effects. Foliar spray has the greatest chance for non-target effects as there is always the potential for some drift of fine droplets from the spray, but even with this method, non-target effects are infrequent and would be limited to minor effects to vegetation in the immediate proximity to the target species. RLRMP standard FW-76 specifically addresses the use of nozzles that produce larger droplet sizes (minimizes drift) and states that nozzles that produce fine droplets are only to be used for hand applications where the distance from nozzle to target does not exceed 8 feet.

Mortality of seedlings and saplings from herbicide use would increase fine woody debris (0-3 inch) on the ground, but fuel accumulations would be minimal and have little impact on overall fuel loadings and future fire effects.

Construction of temporary roads and some reconstruction of existing roads may be necessary to provide adequate access to areas in need of restoration. Construction of temporary roads accessing previously undisturbed ground would result in the removal of all vegetation within the proposed road prism. Road reconstruction typically involves improvements to the existing road surface, and can also include curve widening when necessary which could involve minimal clearing of vegetation. These actions should generate minimal fuels and have little impact on fuel loadings and future fire effects, though roads may be utilized as fire lines or for access to burn units.

Roads are known to be one of the primary vectors of spread for non-native invasive species, thus all disturbed soil in conjunction with road work should be revegetated promptly using genetically appropriate native species or approved non-native but non-persistent species as outlined in Forest Service policy. The location of temporary roads and road reconstruction are site specific actions that would be identified in future tiered decisions and would be further evaluated for effects at that time.

Cumulative Impacts

The cumulative impacts of the Proposed Action consider the contribution of effects from this proposal to past, present, and reasonably foreseeable actions on both federal and adjacent lands. In regards to dry forest communities, the Proposed Action should result in a restoration of these forest types over time, reducing the amount of off-site species present, and moving these communities to a more natural species composition.

A variety of factors have shaped the composition of fuels on the ground in the past and can be expected to do so into the future. Prescribed burns and timber sales have occurred for decades across the south zone of the forest and are planned for the future as well. Widespread insect infestations have affected the forested landscape, and natural disasters such as wildfires, tornados, and ice storms have also played a role. As described above, a variety of mitigations have been put in place to reduce impacts from fuel loading associated with the Proposed Action. Contributions from other sources are described below.

Prescribed burning for fuels reduction is planned across the south zone on a scale of 12,500 ac/yr., much of which may occur within the project area's targeted dry forest types. Prescribed burns reduce fine woody debris (0-3" material), primarily in the litter layer, in the short term until more leaves and pine needles drop to the ground over subsequent years. Prescribed burning through areas with higher amounts of activity fuels from silvicultural treatments may cause more severe fire effects and create a cycle of increased mortality and higher fuel loadings. After a typical low to moderate intensity dormant season burn, the overstory remains essentially intact with a small percentage of trees killed (Elliott et al. 1999; Yaussy and Waldrop 2010). Burning across mechanically thinned areas with higher levels of coarse woody debris on the ground may result in greater overstory mortality than burning in unthinned areas (Iverson et al. 2008; Waldrop et al. 2010; Waldrop et al. 2008). As the overstory trees die, creating snags, they eventually fall and contribute to greater fuel loadings on the ground. Factors such as weather conditions and curing of thinning slash play a role in the fire intensity and resultant mortality.

Timber sales across the south zone in past decades have contributed to greater fuel loadings of primarily fine woody debris with some larger coarse woody debris (>3" material). These fuels consist of tree limbs and tops scattered across the units with some piled up to create jackpots of fuels. Timber sale activity is planned for future years and is expected to continue to contribute to fuel loadings within the sale units.

Insect infestations have played a role in contributing to tree mortality across the south zone. The Hemlock Wooly Adelgid, Emerald Ash Borer, and Southern Pine Beetle have all affected trees across the landscape in previous years and will continue to do so into the future. As the hemlocks, ash, and pines die, those snags will also eventually fall and contribute to fuel loadings on the ground.

Wildfires have burned across the south zone over the past few decades, covering on average less than 1% of the landscape annually. Fire effects generally mimic those of a prescribed burn, although a few of the more intense wildfires have resulted in almost complete overstory mortality in areas ranging from tens to hundreds of acres. These areas contain higher levels of coarse woody debris in various stages of decay as well as an open understory with grass and forbs. Wildfires are expected to play a similar role in future years.

Natural disasters such as tornados and ice storms have affected portions of the south zone in the past. Tornados uprooted trees in a large swath of land several miles long within the past decade, contributing to high levels of fuel loadings. Ice storms have moved through the area, resulting in an overall flush of downed limbs to add to fuel loadings. Both tornados and ice storms may occur in the future across the south zone with similar outcomes.

The southern Forest Futures Project (USDA 2013) provides projected annual rates of spread for numerous high-priority invasive plant species in southern forests, and it is clear that without intervention, this problem is continuing to grow. While a lack of treatment in some areas is allowing increased spread on adjacent lands, mitigations put in place within this Proposed Action, combined with forest-wide assessment and treatment of the species and infestations representing the largest threat to natural areas, make any contribution to cumulative impacts from this project negligible. Continued attention to this problem in all future site specific projects arising from this Proposed Action will be essential to keeping the spread of non-native invasive plant species in check.

Soil

General and Indirect Effects

The proposed activities associated with the treatments being proposed that may impact soil stability, strength, and burn severity desired conditions and are analyzed for effects to soil quality include ground based mechanical harvest, prescribed fire, and herbicide use. All treatments within the Proposed Action will not occur simultaneously, but will be implemented over a long period of time and many of these activities could overlap in space, but most likely not in time. Therefore, the following analysis assumes a sequence of actions that occur in shorter time period than will likely occur. Consequently, the level of effects shown below may be an overestimate of those effects that reduce soil stability, strength, and burn severity than will actually occur.

Ground Based Harvest (mechanical equipment)

Assumptions:

These assumptions are based on the average levels of soil disturbance from recently completed and current harvest activity areas (14 percent), and the maximum level of disturbance (15 percent) as defined in RLRMP Goal 8. The average level of soil disturbance was calculated from sales occurring on the south zone of the Cherokee National Forest from 2015 to present.

- Mechanical treatment will only occur on slopes equal to or less than 35 percent.
- Skid trails and temporary roads for the purpose of timber harvest would not be constructed for sustained distances over 200 feet in areas with slopes of 40% or greater. The 200 foot length can be exceeded however where the skid trail and/or temporary road is needed to traverse a steep area in order to access the remaining harvest unit.
- Potential number of acres proposed for mechanical harvest: 62,308 acres or 20 percent of the south zone.
- Existing temporary roads: The majority of temporary roads that will be used are already existing road prisms on the landscape. This would require re-opening the temporary road by clearing the surface of vegetation, and some maintenance to ensure stability and drainage features are functioning.
- New temporary roads: A ¼ mile by 21 feet wide (0.6 acres) estimate for each harvest unit is assumed in this analysis.
- Log landings: assume 1 log landing per 30 acres and each landing is 0.3 acres in size.
- Primary skid trails: assume for every landing there will be 2 miles (3.4 acres) of 14 foot wide primary skid trail (3+ passes).
- Standard rubber tire skidders are assumed to be used for ground based harvest and transport.
- During harvest operations only the stem of the trees will be removed.

Timber harvest activities usually result in soil disturbance and may affect the soil strength and structure. The effects to these indicators during timber harvest can vary depending upon slope, soil type, and harvest method (Swank et. al., 1989). Other factors that can influence soil disturbance include soil moisture, time of harvest, skidding design, type of equipment, sale administration, and skill of equipment operators. These disturbed soils would occur mostly in areas where log landings, temporary roads, and skid trails would be located. In ideal conditions, logging may disturb no more than 10 percent of the soil surface, in contrast to 40 percent being disturbed by inconsiderate logging (Anderson et al., 1976). RLRMP goals and BMP's keep disturbance levels equal to or less than 15 percent of any activity area. The historic average disturbance level on this Forest is 14 percent of a sale area.

Stability

Loss of ground cover, steepness of slope, and degree of compaction are the most influential attributes effecting potential erosion rates. Timber harvest operations remove biomass, site organic matter (ground cover), and thus affect nutrient cycling and soil stability. Nutrients are lost during harvest by removing the stored nutrients in trees, and additional nutrients are lost if the litter layer and woody debris are removed, more common in whole tree harvesting systems.

Amount of nutrients lost from a site will vary with forest types and site conditions. The amount of nutrients present in the trees will also vary with stand age and development of the humus layer (Grier et. al., 1989). Generally nutrient losses are proportional to the volume of biomass removed from the site. Proposed thinning and restoration activities will harvest the stem only with tree branches, needles, and leaves remaining on site. The large woody debris left on site is a nutrient sink, home to soil organisms and fungi, slows down surface runoff, and is a catchment for sediment. In a study performed by Mann et al. (1988), whole tree harvesting was compared to stem only operations and found that whole tree harvesting resulted in a disproportionately higher nutrient removal because of the large nutrient concentrations in twigs and branches. In addition, Johnson and Curtis (2001) found that on average forest harvesting in North America had little to no effect on soil carbon and nitrogen. Concentrations of carbon and nitrogen may slightly decrease within the first year of harvesting but is not substantial or prolonged (Knoepp and Swank, 1997).

Over time, nutrient loss from stem removal is believed to be replaced by soil weathering and natural inputs. Although nutrients are replaced, cutting alters the processes that regulate nutrient cycling, which frequently accelerates nutrient leaching and loss in dissolved form. However, soils on the forest generally have sufficient levels of nutrients including nitrogen, phosphorus, and potassium to maintain soil productivity and vegetation often responds with rapid growth after thinning. Maintaining the O and A horizons intact as much as possible would help to alleviate nutrient loss from timber harvesting (Hallett and Hornbeck, 1997).

Nutrient loss is greatest on temporary roads, bladed skid roads, and landings since the organic layer and surface soil is removed in the process of construction and/or maintenance. Primary skid trails (those with multiple passes and branching) can be expected to remove organic layers and expose soil as high as 50 percent. Secondary skid trails (small number of passes and no branching), those with surface soils intact, can be expected to have loss of organic surface and soil exposure as high as 25 percent.

Indirect effects of soil nutrient loss include possible reduced growth and yield and increased susceptibility to pathogens, such as root disease and insect infestation. Precipitation and weathering of rocks will continue to make additional available nutrients on site. Annual needle, leaf, and twig fall, forbs, and shrub mortality will continue to recycle nutrients as well. The soil microbe and decomposer communities could also be affected by vegetation removal. Soil microbial activity increases with increased water and warmth (Fisher and Binkley, 2000). This in turn increases soil nutrient availability until vegetation recolonizes the site. When a forest canopy is opened, both the soil moisture and soil temperature is increase from the increased exposure and insolation, which provides a short term beneficial effect to the underground biotic community. Additionally, increased sunlight to the soil surface would result in an increase in grasses, forbs, and shrubs in the understory. This increase in herbaceous vegetation would reduce soil erosion rates by providing ground cover.

A study done by Barrett et al. (2016) estimated that roads, decks, and skid trails generally account for <6 percent of the total harvest activity area, but contributed nearly 63 percent of total estimated erosion within harvest sites. This finding illustrates that erosion tends to be concentrated on relatively small portions of the harvest area, making these locations critical in BMP implementation efforts to reduce overall erosion rates.

During temporary road construction activities, soil may be displaced and exposed. Soil movement would occur, however, the detachment and distance soil particles move would be reduced by limiting water concentration and movement on disturbed surfaces and/or fill materials via BMP's. Drainage structures on temporary roads including broad based dips are used to break up water concentrations similar to water bars.

Multiple studies have looked at erosion rates associated with timber harvest in the Southeast and the findings indicate a range from 0.05-1.1 tons/acre/year (Barrett et al., 2016; Aust and Blinn, 2004; Patric, 1976). These study areas looked at sites with a variety of harvest methods and BMP implementation. Erosion that results from timber harvesting would be greatly modified through time in that disturbance would be temporary and generally a single pulse over a long period of time. A literature review by Aust and Blinn (2004) showed that erosion can be reduced 3-6 times less within two to three years after harvest is complete. These rates are below what NRCS has rated the T-Factor for most of the soils within the restoration area.

Indirect effects occur with time such as accelerated weathering of the soil, increased erosion, and accumulation of soil in depression areas, nutrient leaching, and alteration of organic matter formation.

Strength

Mechanical harvest operations can influence the soil structure through compaction, which ultimately reduces infiltration capacity and increases run off of water contributing to erosion. The potential for compaction increases anytime equipment is used in the forest. The degree of compaction is dependent on the type of equipment utilized, organic matter content, soil texture, and soil moisture. Most compaction of soil occurs during the first pass of equipment, and two or three additional trips will compact it about as much as the vehicle is capable of compacting it (McKee et. al., 1985). A study done by Luckow and Guldin (2007) on 20 timber sale units on the Ouachita National Forest showed that on soils containing 0-15 percent rock fragments and with operations occurring during the dry season, the biggest departure from undisturbed bulk density existed on primary skid trails and log landings resulting in around a 15 percent increase. Areas that only had 1-2 passes or were considered secondary skid trails showed 10 percent or less increase. Additionally, they returned to areas that were logged 25 years prior and found that the bulk density was still higher than natural conditions by 10 percent or less. The natural bulk density for the soils on the sites in this study was 1.32 g/cm³ and 1-2 passes increased bulk density within a range of 1.37-1.42 g/cm³, which is approaching, but not surpassing the thresholds identified as being less than ideal for plant growth.

Design Elements

The Cherokee National Forest monitors BMP implementation each year through a contracted hydrologist. For 2017, they evaluated a total of 16 harvest units and the percentage of correct implementation for forestry practices was 92.3 percent (USDA 2017).

The RLRMP goals and TN BMP's contain measures to reduce negative impacts to soil strength, and structure while also protecting the long term productivity of forest soils. Well designed and effective implementation of BMP's during, and post-operation have been proven to minimize negative impacts to soils and ultimately water quality (Webster et al., 1992; Arthur et al., 1998; Neary et al., 2009; Binkley and Brown, 1993; Stednick, 1996; Swank et al., 2001; Rivenbark and Jackson, 2004; Ward and Jackson, 2004; Clinton, 2011; Grace and Elliot, 2011). These studies all found that BMP's are effective at minimizing and/or preventing erosion and sedimentation from

silvicultural treatments and activities to manage water on forest roads, skid trails, and logging decks. With these BMP's applied, effects of timber harvest on soil loss, sediment yield, and compaction could return to precutting conditions within 1 to 5 years. If any areas suffer severe compaction, however, the effects could last longer than 10 years.

Maintaining organic matter and ground cover on at least 85 percent (RLRMP Goal 8) of the site should minimize changes to nutrient cycling, nutrient availability, erosion, and reduce compaction. Growth of new vegetation from seeding on skid trails, landings, and temporary roads provides ground cover that protects soils from rain and reduces overland water flow which reduces erosion. Roots of grasses initially, followed by denser shrubs later on holds the soil in place and therefore reduces erosion levels.

Preplanning of skid trails, temporary roads and landings both old and new is the key to limiting soil disturbance and the amount of area impacted. Many of the areas proposed for harvesting have existing skid trails and access roads to landings that are either naturally closed with vegetation or were physically closed after the last entry. In an effort to reduce more disturbance across the landscape these trails and roads would typically be reused (see above assumptions). Upon completion of logging activities, temporary roads would be closed, erosion control methods would be applied, and access would be prevented onto skid trails particularly those that may intersect with streams and wet areas. This would prevent access by unauthorized motor vehicles and ensure establishment of a uniform ground cover limiting the exposure of bare soil to erosion.

Road maintenance work consisting of but not limited to grading, spot gravelling, replacing damaged or non-functional culverts, and repairing/maintaining ditch lines would disturb soils. The area impacted is usually limited to the road right of way. Minor amounts of soil disturbance are anticipated and the associated work would help to prevent long term erosion issues. Replacing and maintaining culverts also drains water off the road surfaces quickly before it can travel and build up erosive energy over long distances.

Cherokee National Forest standard operating procedures in addition to those presented in the Design Elements of the EA include the following:

- During survival checks, the timber staff also evaluates the effectiveness of BMP implementation on skid roads, landings, and temporary haul roads. If deficiencies are found, they are addressed with appropriate corrective measures which may include the following: seed, straw, fertilizer, mulch, matting, slash, tops, and others.
- Different seed mixes are used depending on soil type, steepness, time of year, and other factors. Generally, annual grains are used.
- Unacceptable ruts created on skid roads or log landings during harvesting operations are smoothed out, water is diverted appropriately, and erosion is thusly limited.
- If rutting occurs within the unit (off of skid trails), operations are halted by the sale administrator until soil moisture conditions improve.
- Ground cover shall be applied to all bladed areas with greater than 12% slope on any of the SOC map units as part of erosion control. Ground cover, may include mulch, logging slash, natural leaf-fall, etc. These areas will also have drainage controls installed before closure.

Table 3. Intensity, context, duration, and context of likely change for mechanical harvest

Indicator	Intensity of Likely Change	Context of Likely Change	Duration of Likely Change	Why this Likely Change and in this Context is/is not a Significant Impact
Soil stability = 'fair' to 'good' condition class	9,346 acres 15% of the activity area or 3% of the south zone assuming all acres would be treated.	This activity will result in a decrease of surface cover and an increase in erosion rates.	Short term: within 1-5 years vegetation will begin to re- establish stabilizing bare soil areas and reducing erosion rates.	Not significant because 15% or more soil cover should remain in place within the activity area and the estimated erosion rates do not surpass the T- Factor identified by NRCS resulting in a 'fair' to 'good' condition.
Soil strength = 'fair' to 'good' condition class	9,346 acres 15% of the activity area or 3% of the south zone assuming all acres would be treated.	This activity will result in new compaction therefore affecting soil strength.	Long term: depending on the degree of compaction and the methods used to decommission the area the effects could last longer than 10 years.	Not significant because although compaction could likely increase bulk density more than 15% the extent of the compaction across the activity area would be below the 15% threshold resulting in a 'fair' condition.

Prescribed Burning

The impacts of prescribed fire on fuel loads and surface soil conditions can vary considerably depending on fuel characteristics, fuel loading, soil climatic conditions at time of burning, and the resulting soil burn severity. Control of ignition and burning conditions insure that the flame heights or the severity of the burn is within acceptable limits. By doing so, the loss of organic matter, changes in pore space, and infiltration rates are typically too small to detect. The humus and much of the duff layer would remain intact without visibly altering soil properties and qualities on more than 15 percent of the activity area. Monitoring and experience on the Cherokee National Forest has shown that bare mineral soil exposure is typically less than 1 percent within prescribed burn areas. There would be some tree charring. Soil biota is temporarily reduced but the recovery rate is rather quick as long as soil heating is not severe. Fuel concentration areas such as log landings or limb piling areas are more likely to produce more severe or intense burns and soil exposure. The higher fuel concentration can result in a higher soil burn severity. However, this would occur at log landing sites, which are a small portion of the total area. Spring burns tend to consume less ground fuels than fall burns due to the higher soil moisture levels, leaving higher total soil cover levels post fire. Site prep burning is expected to have a higher fire intensity, but the effects on the soil resource are expected to be similar to a typical prescribed burn.

Stability

Many chemical properties and processes occurring in soils depend upon the presence of organic matter. Soil organic matter is particularly important for nutrient supply, cation exchange capacity, and water retention. Burning, however, consumes aboveground organic material (future organic matter), and soil heating can consume soil organic matter. The importance of retaining organic

matter in soils is included in objectives of prescribed fire prescriptions by identifying desired burning conditions that consume above ground fuels in low intensity burning, with low severity. The desired result is to burn the Oi layer which is made up of readily identifiable plant materials (the litter layer). Beneath this layer is the Oe horizon, which contains partially decomposed organic matter, but can still be identifiable as different plant parts (duff layer). The Oa layer is the humus layer of completely decayed and disintegrated organic materials, some of which are usually mixed with the upper mineral soil layers (Knoepp et al., 2005). Mineral soil begins beneath these layers of fresh and or decomposing plant material.

Elliott (2002) described the effects of a prescribed burn treatment in western North Carolina, conducted to restore a pine-hardwood ecosystem. The study assessed fire severity by measuring heat penetration of the burn into the forest floor and mineral soil. Results revealed that little consumption of the Oe + Oa layer occurred during burning, while the litter layer (Oi) was consumed as high as 94 percent. This maintenance of the Oe + Oa layers is critical for site nutrient retention (nitrogen and carbon) and soil stabilization. Burning to keep Oe + Oa layers intact provides protection to the soil surface from erosion loss.

Fire managers cannot control fire weather but they can control ignition timing and type, and consequently fire intensity (Clinton and Vose 2007). Under all site conditions, the longer a prescribed fire persists in one place the more intense the fire and the more likely there will be significant consumption of the humus layer. Minimizing consumption of the humus layer has important implications for long-term site productivity, as this layer is typically the largest reservoir of available site nutrients in these ecosystems. This retention of humus is particularly important during the post-burn recovery period when young woody and herbaceous seedlings are becoming established (Clinton and Vose, 2000). Prescribed burning can enhance overall site quality and productivity over the long-term by stimulating nitrogen cycling processes.

When organic matter is combusted, the stored nutrients are either volatilized or are changed into highly available forms that can be taken up readily by microbial organisms and vegetation. The amount of change in organic matter and nitrogen is directly related to the magnitude of soil heating and the severity of the fire. High and moderate-severity fires cause the greatest losses (Knoepp, 2005). If the Oi layer is primarily what is consumed total nitrogen levels are affected little (Coates et al. 2008) if any, while other elements important in soil productivity, such as calcium, magnesium, potassium, and phosphorus, are released, boosting soil pH, and therefore elevating availability of these nutrients for plant growth and improving soil fertility in the short term.

If a burn is severe, all litter and duff (Oi and Oe) on the forest floor will be consumed, and the quality of the mineral soil will be negatively affected. This in turn affects the soil biota, soil structure, infiltration, permeability, organic matter, fertility, and potentially trigger accelerated erosion and loss of nutrients, increasing suspended solids and sediments and dissolved salts in stream flow (nutrient enrichment).

Fire mangers generally involve light fuels that burn with low intensity/severity, site recovery would be rapid, and erosion would be controlled by presence of charred logs and other lightly burned and unburned woody material spaced throughout the burned area. This would reduce the length of slope/velocity of overland flow and provide traps for detached soils and ash from localized sheet and rill erosion. A study done by Swift et al. (1993) found that during site prep burns, bare soil was only exposed in areas where partially decomposed logs in contact with the

forest floor ignited and smoldered until consumed. Soil erosion in this study produce small volumes in localized patches, additionally, the eroded material remained on site. Multiple other studies (Neary and Currier, 1982; Van Lear and Danielovich, 1988; and Shahlee et al., 1991) report similar results of little to no erosion after light to moderate intensity fires in the southeastern U.S.

In the study done by Van Lear and Danielovich (1988) sediment accumulation was measured one year after burning took place and the results showed that the control area accumulated 0.54 tons/acre/year while the average of the two burned treatments resulted in 0.55 tons/acre/year of sediment. However, burns in forests with a previous soil disturbance history can increase erosion (Ursic, 1970; Van Lear et al., 1985) Soil disturbance caused by skidding during harvest will increase the probability of soil erosion after burning especially if the majority of the slash used to reduce water movement and erosion is consumed by the fire. Implementation of BMP's and design elements would lower the probability of increased erosion after burning. The above referenced literature indicates that any erosion from burning will not amount to the tolerable soil losses or T-Factor.

Fire effects on soils are variable, but fire intensity, duration, antecedent soil moisture, and fuel conditions would not likely create the very high temperatures required to produce gas that penetrates the soil, consuming organic matter, and forming a hydrophobic layer that repels water, reducing infiltration, and water available for plant growth and soil biological activity. In the study by Swift et al. (1993), they found that hydrophobic conditions in the soil or residual forest floor were not apparent and did not contribute to overland flow. The proposed burns would likely only consume the Oi layer and fine woody fuels leaving the majority of coarse woody fuels only charred. Therefore infiltration capacity, structure of aggregates, macro and micro pore space, would likewise be unaffected by under burning as proposed.

Various published scientific studies have concluded that prescribed fire, implemented under managed or controlled conditions, will have negligible effects on the physical, chemical, and biological properties of soils (Neary and Currier, 1982; Knoepp and Swank, 1993; Vose and Swank, 1993; Elliott et al., 2002; Coates et al., 2008). Burning as proposed would largely be of low intensity and primarily consume the Oi layer (projected 60 to 90 percent) and small woody fuels leaving the larger coarser fuels only charred. As long as fire moves fairly quickly across open forest floor, soil temperatures will not increase enough to cause significant heating-induced mortality of microorganisms. Where soil microbes are reduced, they would rapidly recolonize the redeveloping post fire forest floor except in areas subject to more intense heat. Therefore, the low and moderate burn severities that are prescribed for this project will have short term impacts to soil organic matter and microbial communities. These impact will not affect the long term productivity of the area.

This proposal takes advantage of opportunities to utilize roads and natural barriers where possible to reduce the amount of new fireline construction required. Firelines have similar effects as those associated with skid trails and temporary roads. Installation of dozer-constructed fire control lines where they do not currently exist would expose soil surfaces to establish a break between fuel types, increasing the risk of surface erosion from rain and overland flow. Accelerated erosion potential would be greatest immediately after fireline construction but would return to pre-burn levels within 1-5 years following each treatment with the implementation of proper BMP's and design elements.

A study done by Christie et al. (2013) in the ridge and valley as well as the blue ridge physiographic region of Virginia showed that both slope and implementation of BMP's made a significant difference in erosion rates. Slopes over 30 percent showed higher erosion rates, but was only significant for newly constructed dozer line that had not received and rehab or water control features. Newly constructed fireline had an estimated erosion rate of 0.8 tons/acre/year on 0-5 percent slopes, 9.2 tons/acre/year on 6-29 percent slopes, and 40 tons/acre/year on greater than 30 percent slopes. Firelines that received rehab and water control treatments had an estimated erosion rate of 0.08 tons/acre/year on 0-5 percent slopes, 0.4 tons/acre/year on 6-29 percent slopes, and 0.6 tons/acre/year on greater than 30 percent slopes. Therefore using the BMP's and design elements for new firelines should not result in more erosion than the estimated T-Factor for the south zone.

Strength

Firelines constructed with dozers would cause the soil bulk density to increase especially if the lines are maintained for repeated use. This increase in bulk density would be similar to the expected increase from use of harvest equipment on primary skid trails, which is an approximate increase of 15 percent bulk density. This would result in reduced infiltration rates and could result in puddling or rutting depending on the time of year equipment is used. Application of water control features and other BMP's would aid in the proper drainage of water therefore reducing puddling, and ultimately improving the longevity and structural integrity of the firelines.

Soil burn severity

The overall potential for damage to soil by fire as rated by NRCS is:

Potential	Acres	Percent
Low	58,840	94%
Moderate	959	2%
High	491	<1%
Unrated/water/rock	2,018	3%
Total	62,308	100%

It is important to note that this rating assumes that the hypothetical fire was intense enough to remove the entire duff layer and consume the organic matter in the surface layer. As reviewed in the above literature, this situation is extremely unlikely under controlled prescribed burn conditions. With that in mind, there are only 491 acres that received a rating of high potential for damage by fire. The remaining soils classified as either moderate risk or low risk.

Design Elements

Properly designed firelines effectively limit effects to soil resources. Bladed firelines would be constructed so that the mineral soil is exposed. Water control features such as broad based dips or water bars would be installed in order to prevent water from gaining erosive force and the ability to properly drain off the bladed line. Additionally, water flow would be dispersed into the forest buffer prior to reaching streams or other sensitive resources. Rehabilitation of fire control lines installed during prescribed burning would minimize negative impacts to soil productivity (erosion) from fire control lines (Christie et al., 2013). Some of these newly constructed firelines would be allocated or otherwise designated for future use and management as well, but would be stabilized by RLRMP standards, BMPs, and design elements.

Burn plans should identify if any of the soils classified as having a high risk of potential damage by fire are within the burn unit. These areas may require additional attention to ensure soil burn severity is kept low and post-fire reconnaissance should take place to identify if any post fire mitigation is needed within these areas.

Table 4. Intensity, context, duration, and significance of likely change for prescribed fire

Indicator	Intensity of Likely Change	Context of Likely Change	Duration of Likely Change	Why this Likely Change and in this Context is/is not a Significant Impact
Soil stability = 'fair' or 'good' condition class	62,308 or 20% of the south zone assuming all acres are treated.	A minimal loss of surface cover is expected within the activity area and excessive erosion rates are expected to be minimal within the burn area or on rehabbed firelines.	Short term: 1-5 years for vegetation to reestablish and erosion rates to return to pre-burn conditions.	Not significant because surface cover loss is not expected to exceed 15% within the activity area and erosion rates are expected to remain below T-Factor rates therefore maintaining a condition class of 'fair' or 'good'.

Table 4. Intensity, context, duration, and significance of likely change for prescribed fire

Soil	Any area	Increased compaction and	Long term:	Not significant because
strength =	where	decreased infiltration is	Compaction will	the increase in bulk
'fair' or	dozer lines	expected to occur on dozer	remain unless the	density would occur on
'good'	may occur.	lines.	line is	less than 15% of the
condition			decommissioned or	activity area maintaining
class			rehabbed.	a condition class of 'fair'.
Soil burn	62,308 or	A 'good' to 'fair' post fire	Short term: the soil	Not significant because
severity =	20% of the	condition is to be expected.	will recover to pre	the expected condition
'fair' or	south zone	The majority of the south	burn condition	class post burn is
'good'	assuming	zone has a low risk for	within 1-5 years.	expected to be 'good' or
condition	all acres	potential damage by fire.		fair'.
class	are treated.			

Herbicide Use

Assumptions:

- Herbicides will be applied within label requirements and RLRMP standards
- Chemical treatments could include streamline basal bark, hack and squirt, cut stem surface, or foliar spray methods.

For this project, herbicide use would be done in a targeted manner. When spot treatment of herbicide is employed, large patches of total vegetation removal that would result in exposed mineral soil would be unlikely. If mineral soil is not exposed, then soil stability should remain unchanged. If large patches of vegetation are eradicated through the use of herbicide, then the remaining plant residue should arrest any soil movement. Herbicides would most likely be applied through the use of a back pack sprayer, but mechanical equipment could also be used. Soil strength would only be impacted through use of mechanical equipment and is covered under the mechanical equipment section above.

Stability

Herbicide applications to control competing vegetation do not disturb the topsoil layer, do not create additional bare soil, and do not adversely affect watershed condition when used responsibly (Neary and Michael 1996). By utilizing herbicides as opposed to mechanical methods, the soil organic matter is left in place, and off-site soil movement does not increase the loss of nutrients following harvest activities. Maxwell and Neary (1991) concluded that the impact of vegetation management techniques on erosion and sediment losses occurs in this order, herbicides < fire < mechanical.

Additionally, the soils ability to remain productive and aid in plant growth is largely dependent on the microorganism community. Nutrient availability is highly influenced by microbial activity and other chemical parameters, particularly pH. Many nutrients taken up by plant roots are first cycled through a soil organism before becoming available to the plant. Changes to the soil microbial/decomposer community and the environmental fate of the chemical used would be influenced by the persistence and mobility of the chemical in the soil. Each herbicide proposed will be discussed separately with regards to mobility and potential effect to the microbial community.

Glyphosate. Several studies have addressed the environmental fate of glyphosate in soil and water and concluded that the effects are minimal. Glyphosate has a tendency to adsorb strongly to soils and is moderately persistent with a 3 to 130 day half-life (USDA 1984). Mobility, and hence leachability, of a compound in soil depends on its sorption characteristics, i.e. strong sorption to soil solids results almost in immobilization, while a weakly adsorbed compound can be readily leached. Compared with other pesticides, glyphosate possesses unique sorption characteristics in soil. Almost all other pesticides are moderately to weakly absorbed in soils, mainly by soil organic matter. In contrast, glyphosate, which is a small molecule with three polar functional groups (carboxyl, amino and phosphonate groups), is strongly adsorbed by soil minerals (Borgggard and Gimsing, 2008). Schuette (1998) also found that glyphosate will not move readily through soil and leach into non-target areas. Degradation of glyphosate in soils is mainly a biological process accomplished by different microorganisms, but bacteria were found to be the most common agent of degradation (Borgggard and Gimsing, 2008). A study on the effects of glyphosate on microbial biomass (Stratton G. and Stewart K. 1992) found glyphosate generally had no significant effect on the numbers of bacteria or fungi in forest soil and overlying forest litter.

Imazapyr. If imazapyr is used for treatment as part of this project, then the primary effects to soil and water would be: 1) soil persistence and 2) runoff potential. Imazapyr should be applied directly to plants and not soil. If imazapyr gets into the soil, the existing soil pH would affect the mobility or persistence of the chemical. A soil with a pH less than 5 would cause the chemical to bind with the soil, whereas a pH greater than 5 would not bind the chemical to the soil, allowing it to be mobile in the soil solution (Durkin 2011). If imazapyr is mobile in the soil solution, then it could be taken up by plants, degraded by microbes, or leached off-site in heavy rain events (Tu et al. 2001). If imazapyr remains bound to the soil, then it could have a negative effect on plant re-establishment.

Soil-mobile imazapyr is degraded primarily by microbial metabolism (Tu et al. 2001). Sunlight does not degrade imazapyr but it does degrade it in water. Estimates for the soil half-life of imazapyr vary widely (from 25 to 2,972 days) in the published literature (Durkin 2011). Because of this uncertainty, it would be important to adhere to conditions that maximize this chemical's degradation. If a soil is waterlogged and anaerobic, degradation of imazapyr is decreased. As the pH of a soil increases, microbial degradation of imazapyr will decrease (Tu et al. 2001). In general, microbial metabolism increases with increasing temperature and increasing soil moisture).

There is little information available about the effects of imazapyr on the soil microbial and decomposer community. Forlani et al. (1995) reported that imazapyr inhibited growth for some types of soil bacteria in laboratory assays; however, the effects appeared to be species specific. No field studies have been reported.

Triclopyr. Studies have addressed the environmental fate of triclopyr in soil and water (USDA 1996; Ganapathy 1997). Both showed that triclopyr binds to organic matter in the soil and is held near the surface where it degrades more easily than in the lower horizons of the soil. Adsorption of triclopyr is generally characterized as "not strong." Microorganisms degrade triclopyr readily. It degrades more rapidly under warm, moist conditions which favor microbial activity. Persistence varies widely, depending on soil type and climate. Under most conditions triclopyr breaks down relatively quickly and has a half-life in soil of 1.1 to 90 days (NPIC 2002).

Long-term forest and pasture studies found very little indication the triclopyr will leach substantially either horizontally or vertically in loamy soils (SERA, 1996). This reduces the likelihood that the herbicide will leach into streams, lakes, or groundwater. If it does reach water, triclopyr breaks down relatively quickly and has a half-life 1 to 10 days in water (NPIC 2002). Ganapathy (1997) concluded that "with the use of buffer zones around streams and ephemeral drainage routes, forestry applications of triclopyr could be made without harm to nearby streams". The most important breakdown process in water is photolysis (Extoxnet 1996). The USDA (1996) stated that "triclopyr contamination of groundwater has not been reported."

The potential for substantial effects on soil microorganisms appears to be low. The risk assessment (SERA, 2011) reported that laboratory bioassays conducted in artificial growth media suggest a very high degree of variability in the response of soil bacteria and fungi to triclopyr with no adverse effect levels of up to 1000 ppm in some species and growth inhibition at concentrations as low as 0.1 ppm in other species. Modeled concentrations of triclopyr in the top 12 to 36 inches of soil range from about 0.04 to 0.1 ppm for both triclopyr BEE and triclopyr TEA. Some transient inhibition in the growth of some bacteria or fungi could occur as a result of triclopyr application. This inhibition could result in a shift in the population structure of microbial soil communities, but substantial impacts on soil, including gross changes in capacity of soil to support vegetation, do not seem plausible. This assessment is consistent with Forest Service field experience involving the use of triclopyr to manage vegetation.

Design Elements

State BMPs (TDF 2003) require the applicator to "Consider weather conditions (such as temperature, wind speed and precipitation) and equipment capabilities to avoid herbicide drift (p.25)." Mixing the appropriate concentration of herbicide in water is the most common time during which an herbicide spill could occur. Cleaning of equipment and disposal of excess mix are also activities that could result in contamination of soil resources if not conducted appropriately. Thus, the Cherokee National Forest relies both on RLRMP standards and state BMPs related to where mixing, cleaning, and disposal are allowed to prevent a direct spill to water.

Table 5. Intensity, context, duration, and significance of likely change for herbicide use

Indicator	Intensity of Likely Change	Context of Likely Change	Duration of Likely Change	Why this Likely Change and in this Context is/is not a Significant Impact
Soil stability = 'fair' or 'good' condition class	62,308 or 20% of the south zone assuming all acres are treated.	Zero to a minimal loss of surface cover is expected within the activity area and additional erosion is not expected. Effects to microbial communities and future plant growth are not expected.	Short term: 1-5 years for vegetation to reestablish if lost.	Not significant because surface cover loss is not expected to exceed 15% within the activity area and erosion rates are expected to remain below T-Factor rates therefore maintaining a condition class of 'fair' or 'good'.

Cumulative Effects

Past, present, and future activities on both federal and private lands include timber harvesting, prescribed burning, use of herbicides, grazing and agriculture, urban areas, roads and trail maintenance activities, utility corridors, developed and dispersed recreation, wildlife openings, and hemlock conservation areas.

Ground disturbing activities from current conditions, or in projects approved by other decisions, that occur in the project area would continue. The effects estimated for these other projects are described in the respective documentation and may include actions that create areas of bare soil within the boundaries of the activity areas, such as timber harvest, prescribed fire, or roads and trails. Like those effects described in this analysis, these other projects may create conditions that affect soil stability, soil strength, and soil burn severity.

Such activities will or already have resulted in altered soil conditions where old skid trails, landings, and temporary roads were once constructed. As described above, soil stability impacts resulting from such activities are primarily due to loss of soil cover. However, vegetation is estimated to re-vegetate the exposed area within 1-5 years. Therefore with actions that have occurred more than 5 years ago the soil stability has likely returned to more pre-disturbance condition and the residual effects are likely minimal. Future actions could have the same effect on soil stability resulting in a slight increase in erosion levels within the first 1-5 years. Soil strength impacts have and will continue to result in more continuous periods of increased compaction and decreased water infiltration. Although rehabilitation of these sites decreases the duration of the recovery period for soils and lessens the potential for cumulative degradation of soil conditions, the re-opening and use of these areas during successive harvest operations generally results in some decreased soil quality on these sites. Given the evaluated cumulative effects, soil stability is likely to recover quickly while soil strength is likely to recover more slowly resulting in long term soil disturbance.

Periodic prescribed burning activities have been implemented within the south zone and are expected to continue. Impacts on soil stability from past prescribed burning are considered minimal for the majority of areas burned because soil cover (vegetation) begins to recover within the first year. Firelines are present within some of the burn units, but are a small percentage of the activity area. These areas would have the greatest effect on soil strength especially if they are continuously used every 3-5 years. Monitoring of past prescribed burns indicates that all have been within the low to moderate burn intensity categories resulting in a low soil burn severity thus promoting nutrient cycling and vegetative cover. Therefore, even though prescribed fire has occurred and is likely to occur into the future in part of previously planned projects that happen to occur in the south zone, the fire prescriptions are designed to burn at low to moderate intensity and consequently, the effects of these burns are not expected to have long term effects on soil stability, structure, strength, or burn severity.

Herbicides and pesticides have been and will continue to be used on various projects and will be applied within label guidelines to maintain desired soil productivity. These effects have been analyzed in previous NEPA documents.

Other past, present, and reasonably foreseeable activities on federal lands within the south zone include work on areas considered as essential infrastructure and not part of the productive land base. For recreation areas, roads, and rights-of-way activities are performed to ensure the safety of the public and to prevent degradation of infrastructure and the environment. Road or trail

maintenance operations can lead to increases in soil erosion and increases in sediment production. However, these operations may be combined with structural improvements and improvements to drainage structures which reduce soil erosion and sediment production from the road or trail surfaces over the long term. Regardless, as stated previously, these areas are not considered part of the productive land base and therefore soil quality standards do not apply to these areas.

The combined long term effects from past, present, reasonably foreseeable, and the Proposed Action would have some negative effects, but cumulatively would be a small portion of the south zone. As identified in the respective sections above, the RLRMP goals and standards are expected to be met within each activity area. Therefore the majority of the south zone is expected to be left in acceptable potential soil productivity following land management activities.

Unavoidable negative impacts

Although standards, BMP's, and monitoring plans are designed to prevent significant impacts to soil and water, the potential for impacts does exist. Erosion could exceed natural rates in certain locations where roads are being built or maintained, or where other management activities occur. Implementation of the Proposed Action would result in some negative environmental effects that cannot be avoided. Although the formulation of the Proposed Action included avoidance of potential negative environmental effects, some negative impacts to the environment that cannot be completely mitigated and are expected to occur.

Conclusion

After analyzing the direct, indirect, and cumulative effects for each of the measures, The Proposed Action will affect soil stability, strength, and burn severity (Soil Report Project File). The Proposed Action plus those effects resulting from other projects in the project area will result in maintaining the soil indicator current condition.

Summary of Effects

All the activities associated with proposed treatments in the Proposed Action have been analyzed separately as if they were occurring on separate pieces of ground. Although there is the potential that these activities will be occurring over the same piece of ground, it is uncertain as to when treatments may overlap or exactly where. Therefore the estimated affected acres in this report could be a gross overestimation. The largest negative effects to soil quality from the Proposed Action would be impacts to soil structure and strength mostly resulting from use of mechanical equipment (Table 3). The combined long term effects to soil productivity from past, present, reasonably foreseeable, and Proposed Actions would cumulatively be a small portion of the south zone. Therefore the majority of the project area is expected to be left in acceptable potential soil productivity following land management activities adhering to the RLRMP goals and standards as well as the TN BMPs.

Table 6: Long Term Cumulative Impacts on each Soil Indicator for Proposed Action

Indicator	Proposed Action
Soil stability	Short term
Soil strength	Long term, but <15%
Soil burn severity	Short term

Water

General and Indirect Effects

The proposed activities associated with the treatments being proposed that may impact water quality and water yield include temporary road construction, ground based mechanical harvest, prescribed fire, and herbicide use. All treatments within the Proposed Action will not occur simultaneously, but will be implemented over a long period of time and many of these activities could overlap in space, but most likely not in time. The following analysis assumes a sequence of actions that occur in shorter time period than will likely occur. Consequently, the level of effects shown below may be an overestimate of those that will actually occur.

Change in erosion Potential and Percent of Impervious Surfaces

Effects of Temporary Road Construction, Mechanical Vegetation Treatments, and Fireline Construction

Potential general and indirect effects to water quality resulting from sediment loading are greatest from road construction activities, use of mechanical equipment on skid roads and log landings during vegetation treatments, and construction of new fire line.

62,308 acres of the project area have the potential for mechanical vegetation treatments. It is important to note that treatments would not occur at the same time nor would all the acres estimated receive treatment, but rather the treatments would be spread out over multiple years and only occur in areas that are not within desired conditions. The table below presents total acres of potential vegetation treatments by watershed and associated potential soil disturbance however it does not take into account restoration efforts after the treatments have been completed. Without taking into account restoration efforts and the potential overestimation of area to receive treatments within each watershed the numbers in the table below could be an overestimate. Table 7 summarizes watershed ownership, roaded acres, maximum proposed mechanical treatment acres, temp road construction and estimated TIA. Assuming 15% detrimental soil disturbance across the maximum proposed mechanical acres and maximum allowable temporary road construction, the resulting watershed impervious area would range from 0.33% in the Chilhowee Lake watershed to 7.2% in the Ocoee River Dam #1 watershed (mean = 2.27%). Fireline construction is not represented in the table but is estimated to account for less than a 0.5% increase in total watershed impervious area (TIA) in any given watershed and therefore would not cause an exceedance of the 10% threshold.

Table 7. Summary of maximum potential mechanized treatment acres, temporary road construction, associated disturbed soil area, and TIA

Name	Waterhs ed Area (Acres)	NFS Owne rship (%)	Existing TIA (Acres)	Existi ng TIA (%)	Proposed Action Max Mechanical Treatments (Acres)	Proposed Action Max Soil Disturbanc e (Acres)	Estim ated # Units	Temp Road (Miles	Temp Road (Acres	Sum Proposed Action Max Impervious Area (Acres)	Sum Proposed Action Max Impervious Area (%)
Bald River	13867	98%	84	0.61%	75	11	3	1	2	97	0.70%
Ball Play		, , , ,	<u> </u>	010270				_	_		311 0 / 3
Creek-											
Conasauga											
River	74067	82%	487	0.34%	3497	525	117	29	74	1086	1.47%
Ballplay											
Creek	17207	31%	96	0.24%	1818	273	61	15	39	407	2.37%
Big Lost											
Creek	11939	94%	167	1.08%	3516	527	117	29	75	769	6.44%
Chilhowee											
Lake	31601	26%	102	0.01%	8	1	0	0	0	103	0.33%
Citico Creek	45617	90%	375	0.51%	6623	993	221	55	140	1509	3.31%
Coker Creek	15604	51%	119	0.45%	1051	158	35	9	22	299	1.92%
Conasauga											
Creek Lower	28410	9%	114	0.09%	210	31	7	2	4	150	0.53%
Conasauga											
Creek Upper	38181	23%	199	0.21%	2255	338	75	19	48	585	1.53%
Hiwassee											
River-Gee	21114	400/	100	0.220/	5200	705	177	4.4	110	1106	2.550/
Creek	31114	49%	198	0.32%	5300	795	177	44	112	1106	3.55%
North River	11916	100%	115	0.65%	263	39	9	2	6	160	1.34%
Ocoee River Dam #1	36875	84%	453	0.91%	12844	1927	428	107	272	2652	7.19%
Ocoee River	308/3	04%	433	0.91%	12844	1927	428	107	212	2032	7.19%
Dam #2	28231	95%	283	0.69%	2935	440	98	24	62	786	2.78%
Ocoee River	20231	9370	203	0.0770	4933	770	20	∠4	02	700	2.1070
Dam #3	30271	47%	164	0.23%	281	42	9	2	6	212	0.70%
Ocoee River	30271	1770	101	0.2370	201	12	,			212	0.7070
Outlet	28606	14%	126	0.13%	894	134	30	7	19	279	0.98%
Slick Rock			-			-			-		
Creek	10464	100%	47	0.14%		0	0	0	0	47	0.45%

Table 7. Summary of maximum potential mechanized treatment acres, temporary road construction, associated disturbed soil area, and TIA

Name	Waterhs ed Area (Acres)	NFS Owne rship (%)	Existing TIA (Acres)	Existi ng TIA (%)	Proposed Action Max Mechanical Treatments (Acres)	Proposed Action Max Soil Disturbanc e (Acres)	Estim ated # Units	Temp Road (Miles	Temp Road (Acres	Sum Proposed Action Max Impervious Area (Acres)	Sum Proposed Action Max Impervious Area (%)
Spring			,		,	,			Í	,	
Creek	21185	68%	206	0.66%	4834	725	161	40	103	1033	4.88%
Tellico Lake-Little Toqua											
Creek	32967	9%	114	0.03%	374	56	12	3	8	179	0.54%
Tellico River Headwaters	20771	94%	182	0.56%	736	110	25	6	16	307	1.48%
Tellico River Middle	37806	11%	143	0.06%	1868	280	62	16	40	463	1.22%
Tellico River Upper	40877	59%	327	0.49%	4305	646	143	36	91	1064	2.60%
Towee Creek- Hiwassee River	35184	84%	343	0.66%	8307	1246	277	69	176	1766	5.02%
Turtletown Creek	22505	12%	94	0.11%	472	71	16	4	10	175	0.78%

None of the analyzed watersheds would exceed 10% TIA if the maximum proposed mechanical acres were implemented.

Further reducing the expected effects from mechanical treatments under the Proposed Action are recent data from the Cherokee National Forest indicating an average of 14% detrimental soil disturbance from temp roads, log landings, and skid trails in recent timber sales (Beard 2019, USDA 2016, Hermandorfer 2017, Burgoyne and Mondry 2018, unpublished data). Additionally, a recently compiled 5-year average of BMP monitoring data indicates that forestry and road BMP implementation and effectiveness rates are both approximately 94% (Reddington and Jones 2015, Jones 2017a, Jones 2017b, Jones 2018, Jones 2019). No visible sediment was delivered to a waterbody >98% of the time. A non-critical amount of sediment was delivered to a waterbody approximately 2 percent of the time. Only one occurrence of a critical amount of sediment delivered to a waterbody was documented, and this was associated with a legacy road which was located in a topographic low, and therefore had a very long ditchline draining directly to a stream. The deficiency was associated with a legacy issue, not with current timber harvest design.

The risk of increased sediment loading is low due to a brief increase during and immediately after mechanical activities in areas local to the treatments. However, risk is not expected to increase over the entirety of the short-term, or in to the long term at the scale of 6^{th} -field watersheds and the beneficial uses would not be measurably effected.

Effects of Prescribed Fire

Prescribed fire is planned and implemented so that burning does not produce high soil burn severity (SBS). Observations from 2016 wildfires on the Cherokee National Forest documented minimal areas of high SBS, and evidence of sediment production from burned areas and mobilization to surface waters was very limited (Mondry 2016). In addition, post-fire watershed recovery is much faster in the southern Appalachians because of rapid vegetative re-growth that minimizes hillslope erosion (Elliot and Vose 2006). Prescribed fire under the Proposed Action may increase the risk of sediment loading if storm events impact burned areas directly after treatments. However, through the short- and long-term an increased risk of sediment loading from prescribed fire is expected to be low at the 6th-field watershed scale.

Change in Water Quality from Herbicide Use

Under the Proposed Action, herbicides would be used for restoration purposes for targeted species in a targeted manner on a total of up to approximately 62,000 acres in the project area. Glyphosate, imazapyr and triclopyr would be used for pre- and post-harvest site treatments in stands proposed for management. Minimal amounts of chemical would be transmitted to surface waters as these herbicides would be applied on the leaf surface or directed into the vegetation. Timing of application and quantities applied would ensure that no measurable effects to water quality would occur. Overall, the action would have negligible effects on water resources.

Unless otherwise specified, the following information is from Syracuse Environmental Research Associates (SERA) Risk Reports for the specific herbicide used. Effects of the individual herbicides can be found below:

Glyphosate would have minimal to no impacts on water resources. The herbicide is highly adsorbed by and tightly bound in most soils especially those with high organic content. This results in little transference of the herbicide by rain or other water sources from the point of soil

contact. The herbicide is readily metabolized by soil bacteria, and when present in water by aquatic microorganisms. Many species of microorganisms can use glyphosate as a carbon source (SERA 2003a).

Imazapyr is the common name for the active ingredient in Arsenal and Chopper. The herbicide is applied to foliage, freshly cut stumps, or applied to cuts made around the base of a tree. The EPA categorizes Imazapyr as practically non-toxic to mammals, birds, honeybees, fish, and aquatic invertebrates (SERA 2004, Mallipudi et al. 1991).

Triclopyr ester, also a common herbicide used in forestry applications, poses a slightly greater risk to fish and aquatic invertebrates than the other two herbicides. However, in a review of studies looking at the stream flow fate of triclopyr, the highest water concentrations of the herbicide in streams are found where buffer strips are not utilized. When buffer strips are employed, as they would be for the proposed Restoration of Dry Forest Communities on the South Zone of the Cherokee National Forest project, peak concentrations of the chemical have not been found to exceed action levels. Compliance with Forestwide standards for herbicides would minimize herbicide effects on surface water (SERA 2003b).

Herbicide applications to control competing vegetation do not disturb the topsoil layer, do not create additional bare soil, and do not adversely affect watershed condition when used responsibly (Neary and Michael 1996). By utilizing herbicides as opposed to mechanical preand post-preparation methods, the organic matter is left in place, and off-site soil movement does not increase the loss of nutrients following harvest activities. Maxwell and Neary (1991) concluded that the impact of vegetation management techniques on erosion and sediment losses occurs in this order, herbicides < fire < mechanical.

Where buffer strips are used and/or other mitigation measures are employed, herbicides used in forestry management generally do not pose a threat to water quality. The small quantity of herbicide used and the application method and strict handling standards, when combined with streamside management zones, would insure that no measurable direct or indirect effects would occur from proposed herbicide treatments in the project area.

Cumulative Impacts

Effects of past, present, and reasonably foreseeable future activities on both federal and private lands would continue including but not limited to: timber harvesting, road and trail maintenance and construction, prescribed burning, wildfire suppression, use of herbicides, grazing and agriculture, urban areas, utility corridors, developed and dispersed recreation, wildlife openings, illegal OHV use, and natural disasters, These effects when added to effects from the Proposed Action are anticipated to produce a low risk of increased sediment delivery to streams or changes in water yield in the short- or long-term and would not produce a measureable effect on beneficial uses given RLRMP standards, design elements, and BMP's. Herbicide use is not anticipated to produce any measurable changes to water quality.

Overall, the general and indirect effects of the Proposed Action plus the cumulative effects resulting from other projects is likely to result in a "low risk" to beneficial uses because:

- The combination of RLRMP standards, design elements, and best management practices are designed to minimize sedimentation and effects to water quality from herbicide; and
- The foreseeable future actions are not anticipated to result in TIA to rise above 10%.

Summary of Effects

Implementation of the Proposed Action would result in low risks of increased sediment loading, changes in water yield and changes in water quality from herbicide use. Thus, implementation of the Proposed Action would pose a low risk to legally designated beneficial uses which depend on water quality and channel morphology/aquatic habitats (Hydrology Report Project File)

Compliance with RLRMP and Other Relevant Laws, Regulations, and Policies

Clean Water Act

Section 313 of the Clean Water Act requires the Forest Service to adhere to state water quality requirements. Section 319 of the Clean Water Act of 1972 requires the Forest Service to accommodate concerns of States regarding the consistency of federal projects with State nonpoint source pollution control programs. All waters within National Forests are Exceptional Tennessee Waters (TDEC 2013b) and consequently no degradation that threatens the designated uses of these waters is permitted. Provided that the RLRMP standards, BMPs and the proposed Soil and Water Design Elements are properly implemented (installed and maintained) throughout the project area, it is not expected that the project will cause a violation of water quality standards and will not adversely impact designated beneficial uses. Therefore, it would be consistent with the Clean Water Act.

Executive Orders 11988 and 11990 (Floodplains & Wetlands)

At stated in the order, the objective of EO 11988 is to avoid, to the extent possible, the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative. No modification or occupancy of floodplains is proposed with this action. The Proposed Action is consistent with the Executive Order.

EO 11990 requires the Forest Service to take action to minimize destruction, loss, or degradation of wetlands and to preserve the natural and beneficial values of wetlands. The Proposed Action includes design elements to protect wetlands in the project area. Wetlands locations will be identified during site-specific analysis (not at the programmatic level covered by this analysis) and wetlands will be appropriately buffered per the RLRMP. The Proposed Action is therefore consistent with the Executive Order.

Consistency with Law, Regulation, or Policy

Threatened, Endangered, and Proposed Species

The following table summarizes the determinations of effect for each Threatened, Endangered or Proposed Species for the Proposed Action. Detailed analysis is provided in the Biological Assessment (Project File) for each species.

Table 8. Effects Determinations

Scientific Name	Common Name	Status	Determination of Effect	
Myotis grisescens	Gray bat	Е	No effect	
Myotis septentrionalis	Northern long-eared bat	T	May affect, is likely to adversely affect	
Myotis sodalis	Indiana bat	Е	May affect, is likely to adversely affect	
Cyprinella caerulea	Blue shiner	T	No effect	
Erimonax monachus	Spotfin chub	T	No effect	
Etheostoma sitikuense	Citico darter	Е	No effect	
Etheostoma trisella	Trispot Darter	T	No effect	
Noturus baileyi	Smoky madtom	Е	No effect	
Noturus flavipinnis	Yellowfin madtom	T	No effect	
Percina jenkinsi	Conasauga logperch	Е	No effect	
Percina tanasi	Snail darter	T	No effect	
Epioblasma florentina walkeri	Tan (golden) riffleshell	Е	No effect	
Epioblasma metastriata	Upland combshell	Е	No effect	
Epioblasma othcaloogensis	Southern acornshell	Е	No effect	
Hamiota altilis	Fine-lined pocketbook	T	No effect	
Medionidus acutissimus	Alabama moccasinshell	T	No effect	
Medionidus parvulus	Coosa moccasinshell	Е	No effect	
Pleurobema decisum	Southern clubshell	Е	No effect	
Pleurobema georgianum	Southern pigtoe	Е	No effect	
Pleurobema hanleyianum	Georgia pigtoe	Е	No effect	
Pleurobema perovatum	Ovate clubshell	Е	No effect	
Pleuronaia dolabelloides	Slabside pearlymussel	Е	No effect	
Ptychobranchus foremanianus (foramianus)	Triangular (Rayed) kidneyshell	Е	No effect	
Ptychobranchus subtentum	Fluted kidneyshell	Е	No effect	
Villosa trabalis Cumberland bean pearlymussel		Е	No effect	
Isotria medeoloides	Small whorled pogonia	T	No effect	

Management Indicator Species (MIS)

General, Indirect and Cumulative Effects

The entire list of terrestrial wildlife MIS was reviewed and seven species were selected as MIS for the actions proposed for the Restoration of Dry Forest Communities on the South Zone of the Cherokee National Forest Programmatic Project (Table 9). Selection and rationale for these species as MIS are located in the RLRMP and RLRMP Final Environmental Impact Statement (USDA 2004b). Analysis of MIS is in compliance with the National Forest Management Act. The full analysis for each individual species is available in the Wildlife Resources Report (Project File).

Table 9. Management Indicator Species and Associated Purpose

Species Name	Purpose	Selected for Project Analysis?	Reasons for Selection/Non- Selection
Prairie warbler	To help indicate management effects of creating and maintaining early successional forest communities	Yes	The proposed activities could create early successional communities which is the habitat type utilized by this species.
Chestnut-sided warbler	To help indicate management effects of creating and maintaining high elevation early successional forest communities and habitat	Yes	The proposed activities could maintain early successional communities which is the habitat type utilized by this species.
Pine warbler	To help indicate effects of management in pine and pine-oak communities	Yes	The proposed activities occur in the habitat type that is primarily utilized by this species.
Pileated woodpecker	To help indicate management effects on snag dependent wildlife species	Yes	The type of habitat utilized by this species is located within the potential project area.
Scarlet tanager	To help indicate effects of management in xeric oak and oak pine communities	Yes	The proposed activities occur in the habitat type that is utilized by this species.
Ovenbird	To help indicate management effects of wildlife species dependent upon mature forest interior conditions	Yes	The proposed activities occur in the habitat type that is utilized by this species.
Black bear	To help indicate management effects on meeting hunting demand for this species	Yes	This species is known to occur within the habitat type utilized by this species and hunting demand for black bear could be impacted by the proposed activities.

Regional Forester Sensitive Species

General, Indirect and Cumulative Impacts

The following table summarizes the determinations of effect for each Regional Forester Sensitive Species for the Proposed Action. Detailed analysis is provided in Section 3.0 of the Biological Evaluation (Project File) for each species.

Table 10. Summary of Regional Forest Sensitive Species Effects

Taxonomic Group	Scientific Name	Common Name	Determination of Effect
Amphibian	Cryptobranchus alleganiensis	Hellbender	MAII
Crustacean	Cambarus conasaugaensis	Mountain crayfish	MAII
Fish	Erimystax insignis	blotched chub	MAII
Fish	Etheostoma brevirostrum	Holiday darter	MAII
Fish	Etheostoma vulneratum	Wounded darter	MAII
Fish	Ichthyomyzon greeleyi	Mountain brook lamprey	MAII
Fish	Micropterus coosae	redeye bass	MAII
Fish	Percina burtoni	Blotchside logperch	MAII
Fish	Percina kusha	bridled darter	MAII
Fish	Percina squamata	Olive darter	MAII
Insect	Callophrys irus	Frosted elfin	MAII
Insect	Danaus plexippus	Monarch Butterfly	MAII
Insect	Erora laeta	Early Hairstreak	MAII
Insect	Erynnis martialis	Mottled Duskywing	MAII
Insect	Gomphus consanguis	Cherokee clubtail	MAII
Insect	Gomphus viridifrons	Green-faced clubtail	MAII
Insect	Ophiogomphus edmundo	Edmund's snaketail	MAII
Insect	Ophiogomphus incurvatus alleghaniensis	Allegheny snaketail	MAII
Mammal	Corynorhinus rafinesquii	Rafinesque's big-eared bat	MAII
Mammal	Myotis leibii	Eastern small-footed bat	MAII
Mammal	Perimyotis subflavus	Tricolored Bat	MAII
Mussel	Elliptio arctata	delicate spike	MAII
Mussel	Lasmigona holstonia	Tennessee heelsplitter	MAII
Mussel	Pleurobema oviforme	Tennessee clubshell	MAII
Mussel	Pleuronaia gibberum	Tennessee pigtoe	MAII
Mussel	Strophitus connasaugaensis	Alabama creek mussel	MAII
Mussel	Villosa nebulosa	Alabama rainbow	MAII
Mussel	Villosa umbrans	Coosa creekshell	MAII
Reptile	Pituophis melanoleucus	Pine snake	
Snail	Elimia christyi	Christy's elimia	MAII
Snail	Leptoxis virgata	Smooth mudalia	MAII
Non-Vascular Plant	Arthopyrenia degelii	A crustose lichen	MAII*
Non-Vascular Plant	Cephaloziella spinicaulis	A liverwort	MAII*
Non-Vascular Plant	Cheilolejeunea evansii	Evan's cheilolejeunea	MAII*
Non-Vascular Plant	Drepanolejeunea appalachiana	A liverwort	MAII*
Vascular Plant	Botrychium jenmanii	Dixie grapefern	MAII*
Vascular Plant	Buckleya distichophylla	Pirate bush	MAII*

MAII*

MAII*

MAII*

Appalachian spreading Vascular Plant MAII* Cleistesiopsis bifaria pogonia Whorled horsebalm Vascular Plant Collinsonia verticillata MAII* Hairy southern bush-Vascular Plant Diervilla rivularis MAII* honeysuckle Vascular Plant Mountain witch alder Fothergilla major MAII* Fraser's loosestrife MAII* Vascular Plant Lysimachia fraseri Vascular Plant Monotropsis odorata Pigmy pipes MAII* Vascular Plant MAII* Pycnanthemum curvipes Tennessee mountain mint Vascular Plant Thaspium pinnatifidum Cutleaved meadow parsnip MAII*

Table 10. Summary of Regional Forest Sensitive Species Effects

Thermopsis fraxinifolia

Thermopsis mollis

Tsuga caroliniana

Vascular Plant

Vascular Plant

Vascular Plant

NI = "No impact"; BI = "Beneficial impact"; MAII = "May adversely impact individuals, but not likely to result in a loss of viability in the analysis area, nor cause a trend toward federal listing"; LRLV = "Likely to result in a loss of viability in the analysis area, or in a trend toward federal listing"

Ash-leaved bush pea

Appalachian golden banner

Carolina hemlock

Viability Concern Species

Aquatic Viability Species

General and Indirect Effects

The project is not likely to affect aquatic viability species or their habitat for the following reasons: 1) the project does not propose ground disturbance or overstory tree removal within the SMZ, 2) the project would not significantly increase sedimentation or total impermeable area in any watershed (Reddington 2019) and 3) mechanical vegetation management would not be allowed in the EBZ or within the SMZ. Long-term effects to aquatic viability species populations as a result of the Proposed Action would not result in any measurable effect.

Cumulative Effects

Cumulative effects were considered for aquatic habitats across the southern districts of the Cherokee National Forest. Past and current management actions have resulted in the current aquatic habitat conditions found across the planning area. Future actions are not expected to have a significant effect on aquatic viability species because RLRMP standards are designed to protect aquatic habitat. Since there are no general or indirect effects expected as a result of the implementation of this project, there are no expected cumulative effects, above the baseline condition, associated with the Proposed Action.

The entire Aquatic Viability Report is located in the project file.

Terrestrial Viability Species

General, Indirect and Cumulative Effects

The following table (Table 11) displays the terrestrial viability concerns species known to occur in the representative habitats expected to be impacted by the Proposed Action. Detailed analysis is provided in the Wildlife Resources Report (Project File) for each species.

^{*}prescribed burn effects only

Table 11. Viability Concern Species With Known Occurrences in Representative Habitat

Taxonomic Group Scientific Name Common Name F Rank

Taxonomic Group	Scientific Name	Common Name	F Rank
Reptile	Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	F1
Amphibian	Desmognathus aenus	Seepage Salamander	F3
Terrestrial Snail	Glyphyalinia pentadelphia	Pink Glyph	F3
Terrestrial Snail	Heliodiscus fimbriatus	Fringed Coil	F2
Terrestrial Snail	Mesomphix rugeli	Wrinkled Button	F3
Terrestrial Snail	Paravitrea umbilicaris	Open Supercoil	F1
Terrestrial Snail	Stenotrema altispira	Highland Slitmouth	F2
Terrestrial Snail	Stenotrema barbigerum	Fringed Slitmouth	F2

Plant Viability Species

General and Indirect Effects

Silvicultural activities including both commercial and non-commercial vegetation treatments and site preparation for natural vegetation regeneration and planting, are designed to have a long-term beneficial effect on the overall composition and structure of dry forest communities, which should improve habitat for any viability concern plant species that may occur there in the long-term. Ground disturbing effects from the implementation of some of these activities could impact species populations in the short-term however. The use of mechanized equipment, felling of trees, and creation of skid trails, all have the potential to directly impact individual plants. Changes in light conditions and other micro-site parameters (soil moisture, soil compaction, etc.) have the potential to affect local populations. Because such impacts are site specific and this proposal does not evaluate any site specific actions, no direct effects can be attributed here. As a way to ensure such impacts are removed or mitigated at the site specific level, botanical surveys would be conducted if necessary to determine presence of these species prior to the implementation of future site specific activities. Any locations viability concern plant species would be evaluated at that time.

The use of prescribed fire to create and maintain desired habitat conditions, is likewise intended to have a long-term beneficial effect on any viability concern plant species that may occur within dry forest communities. Effects from the use of prescribed fire on viability concern plant species that could potentially occur within dry forest communities have been described in detail in a paper written specifically for these habitats on the Cherokee National Forest (Pistrang 2019). Eighteen species of viability concern are analyzed in that paper. Neutral or beneficial effects are determined for most species, with possible impacts (scorching or mortality) only affecting individuals and not having any negative long-term effects at the population level.

The use of herbicides for restoration purposes would only be applied for targeted species in a targeted manner and would be in full compliance with all label restrictions and RLRMP standards (FW-72 through FW-84, and FW-87). Based upon this, no effects to any viability concern plant species are anticipated.

Construction of temporary roads and some reconstruction of existing roads may be necessary to provide adequate access to areas in need of restoration. Ground disturbance associated with

these activities has the potential to directly impact individual plants. Because such impacts are site specific and this proposal does not evaluate any site specific actions, no direct effects can be attributed here. As a way to ensure such impacts are removed or mitigated at the site specific level, botanical surveys would be conducted if necessary to determine presence of these species prior to the implementation of future site specific activities. Any locations for viability concern plant species would be evaluated at that time.

Cumulative Impacts

No site specific actions would be authorized as a part of this Proposed Action, thus direct impacts to viability concern plant species from ground disturbing activities would be deferred to future site specific analysis. Mitigations put in place for these species however, are designed to ensure continued viability for all these species groups on the planning area and would be applied to all future tiered decisions.

Anticipated effects from prescribed fire are primarily neutral or beneficial for most species. In all cases, any populations that are present would be expected to remain viable, and thus there would be no incremental contribution to cumulative effects to these species from this proposal. The status of most species' range-wide population trends can be found online (NatureServe 2019) and include impacts that can be attributed to activities within species' habitats occurring on non-federal lands. Forest Service policy is to maintain viability for these species on the planning unit, thus federal lands remain the primary sites for conservation for many of these species. Sites not occurring on protected lands remain susceptible to future declines.

National Historic Preservation Act, Archaeological Resources Protection Act, Native American Graves Protection and Repatriation Act

Introduction

Cultural resources are the tangible remains of past human activity and may include archaeological sites, buildings, structures, cultural landscapes and the locations of traditional practices (Traditional Cultural Properties). They are fragile and non-renewable which means they cannot be remade or rebuilt. As a result, the protection of significant cultural resources, which are those eligible for listing on the National Register of Historic Places (NRHP), is regulated and controlled by a rather stringent and overlapping series of historic preservation laws, regulations and policies. Accountability is high because of well-organized external oversight groups including the State Historic Preservation Office (SHPO), federally recognized Tribes and their Tribal Historic Preservation Officers (THPOs), and the Advisory Council on Historic Preservation (ACHP).

The project area for the Restoration of Dry Forest Communities on the South Zone of the Cherokee National Forest is spread across the Tellico and Ocoee-Hiwassee Ranger Districts and is comprised of approximately 62,000 acres. Of this project area, approximately 13,000 acres have been surveyed for cultural resources and over 125 cultural resource sites have been identified. Most of these sites have not been evaluated for NRHP eligibility and therefore must be considered and treated as eligible until evaluated. Digital Model Elevation (DEM) analysis shows that approximately 56,000 acres of the proposed project area have a slope greater than 15 percent and therefore are considered to have a low probability for containing/retaining significant cultural resources.

General and Indirect Effects

Silvicultural Activities

Proposed silvicultural activities include commercial and pre-commercial thinning treatments, seed tree cuts, and clear cuts. There is the potential that some of these treatments will include ground disturbing activities that could directly affect cultural resources.

Prescribed Fire

Prescribed fire would be used to create and maintain desired forest conditions and to enhance the success of forest regeneration on sites that require planting. Streams and existing roads and trails will be the preferred option for fire containment lines and containment lines of these types, along with the prescribed fire itself, are generally considered not to have the potential to affect cultural resources. Construction of containment lines by bulldozer or other heavy mechanical equipment does has the potential to directly affect cultural resources through ground disturbance.

Herbicide Use

Herbicides would be used for restoration purposes and will used in a targeted manner towards targeted species. Herbicide use does not involve ground disturbance and does not have the potential to directly affect cultural resources.

Temporary Road Construction

Construction of temporary roads has the potential to directly affect cultural resources.

Summary

Actions that have no associated ground disturbance will be found to have no potential to directly affect cultural resources. However, there may be indirect effects to cultural resources, such as audible or visual disturbances/changes to the setting/surrounding environment and these must also be considered. As each project undertaking is proposed, the undertaking will be subjected to the Section 106 process of the National Historic Preservation Act as outlined in 36 CFR 800. Consultation with the Tennessee SHPO and the ten federally recognized tribes with which the Cherokee National Forest consults will take place and a determination of effect to cultural resources will be submitted to the Tennessee SHPO for concurrence.

Cumulative Impacts

Cumulative effects are defined as the result of incremental effects of the project when added to other past, present, and reasonably foreseeable future actions. Cumulative effects on Cultural Resources are expected to be minor since cumulative effects to known heritage sites from all management activities should be slight as inventory, assessment, protection, and mitigation measures would be implemented prior to initiation of each project.

Executive Order 12898 (Environmental Justice)

General. Indirect. and Cumulative Effects

The Proposed Action is compliant with Executive Order 12898 (1994), Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations.

Though low-income and minority populations exist in the analysis area, it is difficult to assess the degree of impact each alternative presents to these groups due to other variables. The best information suggests that the Proposed Action is not expected to have a disproportionately high

and adverse human health or environmental effect on minority and low-income groups, especially when compared to other groups. The activities were proposed for their ecological or recreational importance and not based on proximity to low-income and minority populations.

Travel Analysis Report (TAR)

General, Indirect, and Cumulative Effects

A Transportation Analysis Report was prepared for the Cherokee National Forest (CNF 2016) in compliance with FSM 7712 (FSM 2016) and FSH 7709.55, Chapter 20 (FSH 2016). The TAR is to inform decisions relating to administration of the forest transportation system and help to identify proposals for changes in travel management direction. The TAP is not a decision-making process. Any proposals resulting from the TAR may be addressed in following site specific environmental analyses.

Scenery and Recreation

General and Indirect Effects

Due to the wide range of scenic resources potentially affected by the Proposed Action, site-specific analysis is needed to accurately evaluate general and indirect effects for specific actions. The resiliency of vegetation in the southern Appalachian Mountains should be taken into consideration when disclosing the temporal nature of effects to scenic resources, the consistency with assigned Scenic Integrity Objectives (SIOs) and the application of scenery design features. Depending on treatment methods, many alterations to forest vegetation would not be noticeable to the casual forest visitor 10 to 20 years after implementation. Restoration of these "departed ecosystems" will result in the scenic character of the treatment areas being increasingly natural-appearing over time.

Portions of recreation sites or trails may be temporarily closed during vegetation treatments for safety reasons. Access roads to developed recreation sites and existing trails may experience temporary increases in use by heavy equipment and treatment teams. Access roads may be degraded due to increase in use. Proliferation of illegal routes (e.g. social trails) could result from the creation of temporary access roads or re-opening of previously closed roads or trails to support vegetation treatment work. All proposed transportation improvements are temporary, meaning they will have no impact on existing Recreation Opportunity Spectrum (ROS) classifications. Site-specific opportunities may arise to move areas closer to the desired ROS classifications prescribed in the RLRMP. Site-specific opportunities may also arise to improve trail alignments for increased sustainability.

See project file for the entire analysis on Scenery and Recreation.

Cumulative Impacts

Recreation use on the Cherokee National Forest has increased 53% over the last 10 years, which is consistent with the RLRMP analysis of 50% growth in recreation use from 1989 to 2004 and the Southern Appalachian Assessment's projection of accelerating growth (USDA 2007) (USDA 2012) (USDA 2017) (Federal and State Agencies 1996). Population in the counties surrounding the south zone of the Cherokee National Forest are expected to grow 0.9% annually over the next 40 years, with the majority of the growth occurring outside the major population center of the area, Chattanooga, TN (McBride 2013). All indicators point to foreseeable, increasing population

growth and recreational use on the Cherokee National Forest over the expected time period of this project. These factors could lead to increased interest in protecting and preserving scenic resources and recreational opportunities in the project area by growing numbers of users, as well as state and local governments viewing scenic and recreational resource protection as an important part of their continued economic development.

Cumulative effects to the scenic resource are also foreseeable from multiple treatments taking place in the same view sheds or along the same scenic and historic corridors, but the wide range of treatment options, timeframes, and mitigating design features necessitates site-specific analysis (Ribe 2005) (Palmer 2008) (Aubry, Halpern & Peterson 2009) (Kearney, Tilt & Bradley 2010) (Chamberlain & Meitner 2012).

Agencies or Persons Consulted

The Forest Service consulted the following individuals, Federal, State, tribal, and local agencies during the development of this EA:

FEDERAL, STATE, AND LOCAL **AGENCIES:**

Akins, James - Tennessee Wildlife Resources

Agency (TWRA)

Atchley, Michael – Division of Water Resources

Call. Geoff – USDI Fish and Wildlife Service

Firestone, Hoyt - Polk County Executive

Ingram, Mitch - Monroe County Mayor

Innes, Jennifer - Division of Water Resources

(TDEC)

McCoy, Roger, Division of Natural Heritage

(TDEC)

Miles, Kirk - TWRA

Sowders, Gina - Division of Forestry (TDA)

Tennessee Historical Commission

USDI Fish and Wildlife Service

Wear, Brandon - TWRA

TRIBES:

Alabama-Quassarte Tribal Town

United Keetoowah Band of Cherokee Indians

Cherokee Nation of Oklahoma

Eastern Band of Cherokee Indians

Muscogee (Creek) Nation

Kialegge Tribal Town

Poarch Band of Creek Indians

Alabama-Coushatta Tribe of Texas

Thlopthlocco Tribal Town

OTHERS:

Adair, Nick

Artley, Dick

Benton MacKaye Trail Association (BMTA)

Bivens, Vance

Busscher, Peter -BMTA

Calfee, Bill

Callaway, Mike

Coxen, Chris - National Wild Turkey Federation

Chapman, Charles

Clatterbuck, Wayne

Duckett, Barry

Duckett, Gary

Dunn, Larry

Evans, Sam - Southern Environmental Law Center

Falls, Claude – Rugged Grouse Society (RGS)

Francisco, Sarah - SELC

Freichs, Terry

Guthie, Julie - Cherokee Forest Voices (CFV)

Hood, Aaron

Horton, Jim

Irwin, Hugh

Ives, Ken - RGS

Johnson, Kirk

Johnston, Vicki

Jones, Ken

Kelly, Josh

King, Jody

Miller, Eric

Lowie, Dwight

Medlock, Katherine - The Nature Conservancy

Mitchell, Joanne

Mounger, Davis - Heartwood

Murray, Catherine - CFV

Myers, Ben - Tennessee Forestry Association (TFA)

Norwood, Alan Ordiway, Linda - RGS Ploetz, Bob Reid, Tazz Russell, Sandra Schubert, Martin - TFA Shaw, Ken Skelton, William Sowders, Delores Switzer, Harry Webb, Jim West, Anthony

Literature Cited

Aquatic

Reddington, A. 2019. Hydrology Report, Restoration of Dry Forest Communities of the South Zone of the Cherokee National Forest. Supervisors Office, Cherokee National Forest. Cleveland, Tennessee.

General

Cherokee National Forest. 2016. Travel Analysis Process (TAP) Report. 41 pages.

- Executive Order 12898. "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations". 59 Federal Register 32. 11 February 1994
- Irwin, H. 1996. Tennessee's Mountain Treasures: The Unprotected Wildlands of the Cherokee National Forest. The Wilderness Society, Washington DC.
- The Nature Conservancy. 2018. Cherokee National Forest South Zone Collaborative Restoration Recommendations for the Management of Off-Site Pine in Dry Forest Communities. TN Chapter of TNC, Knoxville, TN. 33 pages.
- NatureServe 2013. International Ecological Classification Standard: Terrestrial Ecological Classifications. Central Databases. Arlington, VA. U.S.A. Data current as of 12 July 2013. http://explorer.natureserve.org/classeco.htm
- Shafale, Michael P. 2012. Guide to the Natural Communities of North Carolina, Fourth Approximation. NC Natural Heritage Program
- Simon, S. 2016. Ecological Zones on the Chattahoochee and Cherokee (south) National Forest: 1st Approximation. Ecological Modeling and Fire Ecology Inc., Asheville, NC. 30 pages.
- USDA Forest Service. 2004. Revised Land and Resource Management Plan, Cherokee National Forest. Forest Service Southern Region. Management Bulletin R8-MB 114A. 463 pages.
- USDA Forest Service. 2004b. Final Environmental Impact Statement for the Revised Land and Resource Management Plan for the Cherokee National Forest. U.S. Department of Agriculture, Forest Service, Southern Region, Cherokee National Forest, Cleveland, TN. 535 pp.
- USDA Forest Service. 2004c. Appendices for the Environmental Impact Statement for the Revised Land and Resource Management Plan. U.S. Department of Agriculture, Forest Service, Southern Region, Cherokee National Forest, Cleveland, TN. 380 pp.
- USDA Forest Service, U.S. Department of Agriculture. 2016. Travel Management, FSM 7712
- USDA Forest Service, U.S. Department of Agriculture. 2016. FSH 7709.55 Chapter 20

Scenery

- Aubry, K. B., Halpern, C. B., & Peterson, C. E. (2009). Variable-retention harvests in the Pacific Northwest: A review of short-term findings from the DEMO study. *Forest Ecology and Management*, 398-408.
- Chamberlain, B. C., & Meitner, M. J. (2012). Quantifying the effects of harvest block design on aesthetic preferences. *Canadian Journal of Forest Research*, 2106-2117.
- Federal and State Agencies. (1996). *The Southern Appalachian Assessment: Summary Report.* Pisgah Forest, NC: Southern Appalachian Man and the Biosphere Cooperative.
- Kearney, A. R., Tilt, J. R., & Bradley, G. R. (2010). The Effects of Forest Regeneration on Preferences for Forest Treatments among Foresters, Environmentalists, and the General Public. *Journal of Forestry*, 215-229.
- McBride Dale Clarion. (2013). *Thrive 2055: Trends and Forces Report*. Chattanooga, TN: Thrive Regional Partnership.
- Palmer, J. F. (2008). The perceived scenic effects of clearcutting in the White Mountains of New Hampshire, USA. *Journal of Environmental Management*, 167-183.
- Ribe, R. G. (2005). Aesthetic perceptions of green-tree retention harvests in vista views: The interaction of cut level, retention pattern and harvest shape. *Landscape and Urban Planning*, 277-293.
- USDA. (2007). *Visitor Use Report*. Washington, DC: US Forest Service, National Visitor Use Monitoring Program.
- USDA. (2012). *Visitor Use Report*. Washington, DC: US Forest Service, National Visitor Use Monitoring Program.
- USDA. (2017). *Visitor Use Report*. Washington, DC: US Forest Service, National Visitor Use Monitoring Program.

Soil

- Anderson, H.W., Hoover, M.D. and Reinhart, K.G. 1976. Forests and water: effects of forest management on floods, sedimentation, and water supply. General Technical Report PSW-018. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. p. 115.
- Arthur, M.A., Coltharp, G.B., and Brown, D.L. 1998. Effects of best management practices on forest stream water quality in Eastern Kentucky. Journal of the American Water Resources Association. 34(3):481-495.
- Aust, W.M. and Blinn, C.R. 2004. Forestry best management practices for timber harvesting and site preparation in the eastern United States: An overview of water quality and productivity research during the past 20 years (1982–2002). Water, Air and Soil Pollution: Focus, 4(1):5-36.
- Barrett, S.M., Aust, W.M., Bolding, M.C., Lakel III, W.A., and Munsell, J.F. 2016. Estimated erosion, ground cover, and best management practices audit details for postharvest evaluations of biomass and conventional clearcut harvests. J. For. 114(1):9-16.
- Binkley, D. and Brown, T.C. 1993. Forest practices as nonpoint sources of pollution in North America. Water Resources Bulletin. 29(6):729-740.

- Borggaard, O.K. and A.L. Gimsing. 2008. Fate of glyphosate in soil and the possibility of leaching to ground and surface waters: a review. Pest Management Science, 64:441-456.
- Christie, A.M., Aust, W.M., Zedaker, S.M. and Strahm, B.D. 2013. Potential erosion from bladed firelines in the Appalachian region estimated with USLE-Forest and WEPP models. Southern Journal of Applied Forestry, 37(3):140-147.
- Coates, T.A., Boerner, R.E.J., Waldrop, T.A., and Yaussy, D.A. 2008. Soil Nitrogen Transformations under alternative management strategies in Appalachian forests. Soil Sci. Soc. AM. J. 72:558-565.
- Clinton, B.D. 2011. Stream water responses to timber harvest: riparian buffer width effectiveness. Forest Ecology and Management. 261:979-988.
- Clinton, B.D., and Vose, J.M.. 2000. Plant succession and community restoration following felling and burning in the southern Appalachian Mountains. Pages 22-29 in W. Keith Moser and Cynthia E Moser (eds.). Fire and forest ecology: innovative silviculture and vegetation management. Tall Timbers Fire Ecology Conference Proceedings, No. 21. Tall Timbers Research Station, Tallahassee, FL.
- Clinton, B.D., and Vose, J.M. 2007. Fuels consumption and nitrogen loss following prescribed fire: a comparison of prescription types in the Southern Appalachians. Gen. Tech. Rep. SRS–101. U.S. Department of Agriculture, Forest Service, Southern Research Station: 231-240.
- Durkin, P. 2011. Imazapyr, human health and ecological risk assessment, final report for USDA FS, Southern Region. Syracuse Environmental Research Associates, Inc. Manlius, NY. EFSA (European Food Safety Authority). 2012. Conclusion on the peer review of the pesticide risk assessment of the active substance fluazifop-P (evaluated variant of fluazifop-P-butyl). EFSA Journal. 10(11):2945. 95 pp. Available at: http://www.efsa.europa.eu/en/efsajournal/pub/2945.htm (Cited in SERA 2014).
- Elliott, K.J., Vose, J.M., and Clinton, B.D. 2002. Growth of eastern white pine (*Pinus strobus* L.) related to forest floor consumption by prescribed fire in the Southern Appalachians. Southern Journal of Applied Forestry. 26(1):18-25.
- Extoxnet. 1996. Triclopyr, Pesticide Information Profile. http://extoxnet.orst.edu/pips/triclopy.htm
- Fisher, F., and Binkley, D. 2000. Ecology end Management of Forest Soils, 3rd ed. John Wiley & Sons, New York, NY. p. 490.
- Forlani, G., M. Mantelli, M. Branzoni, E. Nielsen, F. Favilli. 1995. Differential sensitivity of plant-associated bacteria to sulfonylurea and imidazolinone herbicides. Plant and Soil 176(2):243-253.
- Ganapathy, C. 1997. Environmental fate of triclopyr. Environmental Monitoring & Pest Management Branch, Department of Pesticide Regulation, Sacramento, CA 95814-5624. http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/triclopyr.pdf. 18 p.
- Grace, J.M., and Elliot, W.J. 2011. Influence of forest roads and BMP's on soil erosion. ASABE Paper No. 1110633. p. 1-11.
- Grier, C.C. and Lee, K.M. 1989. Productivity of forests of the United States and its relation to soil and site factors and management practices: a review. Gen. Tech. Rep. PNW-GTR-222. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 51 p. 222.

- Hallett, R.A. and Hornbeck, J.W. 1997. Foliar and soil nutrient relationships in red oak and white pine forests. Canadian Journal of Forest Research, 27(8):1233-1244.
- Johnson, D.W. and Curtis, P.S. 2001. Effects of forest management on soil C and N storage: meta-analysis. Forest Ecology and Management, 140(2-3):227-238.
- Knoepp, J.D. and Swank, W.T. 1993. Site preparation burning to improve southern Appalachian pine-hardwood stands: nitrogen responses in soil, soil water, and streams. Can. J. For. Res. 23:2263-2270.
- Knoepp, J.D. and Swank, W.T. 1997. Long-term effects of commercial sawlog harvest on soil cation concentrations. Forest Ecology and Management. 93:1-7.
- Knoepp, J.D., DeBano, L.F. Neary, D.G. 2005. Chapter 3: Soil Chemistry. In: Neary, D.G., Ryan, K.C., DeBano, L.F. eds. Wildland fire in ecosystems: effects of fire on soils and water. Gen. Tech. Rep. RMRS-GTR-42-vol.4. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 53-71.
- Luckow, K.R., Guldin, J.M. 2007. Soil compaction study of 20 timber-harvest units on the Ouachita National Forest. In: Furniss, M.J., Clifton, C.F. Ronnenberg, K.L., eds. Advancing the fundamental sciences: proceedings of the Forest Service national earth sciences conference. Gen. Tech. Rep. PNW-GTR-689. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 341-351.
- Mann, L.K., Johnson, D.W., West, D.C., Cole, D.W., Hornbeck, J.W., Martin, C.W., Riekerk, H., Smith, C.T., Swank, W.T., Tritton, L.M. and Van Lear, D.H. 1988. Effects of whole-tree and stem-only clearcutting on postharvest hydrologic losses, nutrient capital, and regrowth. Forest Science, 34(2):412-428.
- Maxwell, J.R., and Neary, D.G. 1991. Vegetation management effects on sediment yields. pp. 12-55 to 12-63, IN: T. Shou-Shou and K. Yung-Huang (eds.) Proceedings of the 5th Federal Interagency Sediment Conference, Vol. 2. March 18-21, 1991, Las Vegas, NV, Federal Energy Regulatory Commission, Washington, D.C.
- McKee, W.H. Jr., Hatchell, G.E., Tiarks, A.E. 1985. A Loblolly Pine Management Guide: Managing Site Damage from Logging. Gen. Tech. Rep. SE-32. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 21 p.
- National Pesticide Information Center (NPIC). 2002. Triclopyr; General fact sheet. Oregon State University. http://npic.orst.edu/factsheets/triclogen.pdf. 4 p.
- Neary, D.G. and Currier, J.B. 1982. Impact of wildfire and watershed restoration on water quality in South Carolina's Blue Ridge Mountains. Southern Journal of Applied Forestry, 6(2):81-90.
- Neary, D.G., Ice, G.G. and Jackson, C.R. 2009. Linkages between forest soils and water quality and quantity. Forest Ecology and Management. 258(1):2269-2281.
- Neary, D.G., and Michael, J.L. 1996. Herbicides protecting long-term sustainability and water quality in forest ecosystems. New Zealand Journal of Forestry Science 26:241-264.
- Patric, J.H. 1976. Soil erosion in the eastern forest. Journal of Forestry, 74(10):671-677.

- Rivenbark, B.L. and Jackson, C.R. 2004. Concentrated flow breakthroughs moving through silvicultural streamside management zones: South-eastern Piedmont, USA. Journal of the American Water Resources Association. 40(4):1043-1052.
- Shahlaee, A.K., Nutter, W.L., Morris, L.A. and Robichaud, P.R. 1991. Erosion studies in burned forest sites of Georgia. Georgia Institute of Technology.
- Schuette, J. 1998. Environmental fate of glyphosate. http://www.cdpr.ca.gov/docs/emon/pubs/fatememo/glyphos.pdf. 13 p.
- Stednick, J.D. 1996. Monitoring the effects of timber water yield harvest on annual water yield. Journal of Hydrology. 176:79-95.
- Stratton, G.L, and K.E. Stewart. 1992. Glyphosate Effects on Microbial Biomass in a Coniferous Forest Soil. Environ. Tox. And Water Quality: An Inter. J. 7:223-236.
- Swank, W.T., DeBano, L.F. and Nelson, D. 1989. Effects of timber management practices on soil and water. Burns, Russell [Tech. comp.]. The scientific basis for silvicultural and management decisions in the National Forest System. GTR-WO-55. Washington, DC. USDA Forest Service, p.79-106.
- Swank, W.T., Vose, J.M., Elliott, K.J. 2001. Long term hydrologic and water quality responses following commercial clearcutting of mixed hardwoods on a southern Appalachain catchment. Forest Ecology and Management. 143:163-178.
- Swift, L.W., Elliott, K.J., Ottmar, R.D. and Vihanek, R.E. 1993. Site preparation burning to improve southern Appalachain pine-hardwood stands: fire characteristics and soil erosion, moisture, and temperature. Can. J. For. Res. 23:2242-2254.
- Syracuse Environmental Research Associates (SERA), Inc. 1996. Selected Commercial Formulations of Triclopyr—Garlon 3A and Garlon 4; Risk Assessment Final Report. Washington, DC: U.S. Department of Agriculture, Forest Service, Forest Health Protection. 121 p. Administrative Report. On file with: Forest Health Protection Staff, USDA-Forest Service, P.O. Box 96090, Washington, DC 20090-6090. In: USDA Forest Service, Pacific Northwest Region, 1996. Triclopyr: herbicide information profile. https://studylib.net/doc/11289773/selected-commercial-formulations-of-triclopyr---garlon-3a... 14 p.
- Syracuse Environmental Research Associates (SERA), Inc. 2011. Triclopyr–Human Health and Ecological Risk Assessment Final Report. Task No. 52-25. SERA TR- 052-25-03a. http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-25-03aTriclopyr.pdf
- Tennessee Department of Agriculture, Division of Forestry (TDF). 2003. Guide to Forestry Best Management Practices.
- Tu, M., C. Hurd, and J.M. Randall. 2001. Weed control methods handbook: tools and techniques for use in natural areas. The Nature Conservancy. 219 pp.
- Ursic, S.J. 1970. Hydrologic effects of prescribed burning and deadening upland hardwoods in northern Mississippi. Res. Pap. SO-54. New Orleans, LA: US Department of Agriculture, Forest Service, Southern Forest Experiment Station. 15 p., 54.
- USDA Forest Service, U.S. Department of Agriculture. 1984. Pesticide Background Statements. Volume 1. Herbicides. Agriculture Handbook No. 663.

- USDA Forest Service, Pacific Northwest Region. 1996. Triclopyr: herbicide information profile. http://www.fs.fed.us/r6/nr/fid/pubsweb/tri.pdf. 14 p.
- USDA Forest Service, U.S. Department of Agriculture. 2017. Cherokee National Forest Best Management Practices Monitoring.
- Van Lear, D.H., Douglass, J.E., Cox, S.K. and Augspurger, M.K. 1985. Sediment and Nutrient Export in Runoff from Burned and Harvested Pine Watersheds in the South Carolina Piedmont. Journal of Environmental Quality, 14(2):169-174.
- Van Lear, D.H. and Danielovich, S.J. 1988. Soil movement after broadcast burning in the southern Appalachians. Southern Journal of Applied Forestry, 12(1):49-53.
- Vose, J.M. and Swank, W.T. 1993. Site preparation burning to improve southern Appalachain pine-hardwood stands: above ground biomass, forest floor mass, and nitrogen and carbon pools. Can. J. For. Res. 23:2255-2262.
- Ward, J.M., and Jackson, C.R. 2004. Sediment trapping within forestry streamside management zones: Georgia piedmont, USA. Journal of the American Water Resources Association. 40(6):1421-1431.
- Webster, J.R., Golladay, S.W., Benfield, E.F., Meyer, J.L., Swank, W.T. and Wallace, J.R. 1992. Overview of stream research at Coweeta Hydrologic Laboratory. River Conservation and Management.

Vegetation/Botany

- Abrams, M.D. 2005. Prescribed Fire in Eastern Oak Forests: Is Time Running Out? NJAF 22(3):190-196.
- Arthur, M.A., Paratley, R.D., and B.A. Blankenship. 1998. Single and Repeated Fires Affect Survival and Regeneration of Woody and Herbaceous Species in an Oak-Pine Forest. Journal of the Torrey Botanical Society 125(3):225-236.
- Ayres, H.B. and W.W. Ashe. 1905. The Southern Appalachian Forests. U.S. Geological Survey. Professional Paper No. 37. Government Printing Office, Washington.
- Blankenship, B.A.; Arthur, M.A. 1999. Prescribed fire affects eastern white pine recruitment and survival on eastern Kentucky ridgetops. Southern Journal of Applied Forestry. 23(3): 144-150.
- Blankenship, B.A.; Arthur, M.A. 2006. Stand structure over 9 years in burned and fire-excluded oak stands on the Cumberland Plateau, Kentucky. Forest Ecology and Management. 225: 134-145.
- Brooks, M.L., D'Antonio, C.M., Richardson, D.M., Grace, J.B., Keeley, J.E., DiTomaso, J.M., Hobbs, R.J., Pellant, M., and D. Pyke. 2004. Effects of Invasive Alien Plants on Fire Regimes. Bioscience Vol. 54(7):677-688.
- Brown, J.K., E.D. Reinhardt, and K.A. Kramer. 2003. Coarse Woody Debris: Managing Benefits and Fire Hazard in the Recovering Forest. (U.S. Department of Agriculture Forest Service Rocky Mountain Research Station, Ogden, UT), RMRS-GTR-105. 16p.
- DeSelm, H.R. and E.E. Clebsch. 1990. Response Types to Prescribed Fire in Oak Forest Understory. Pages 22-33 in: Fire and the Environment: Ecological and Cultural Perspectives. Proceedings of

- an International Symposium. Knoxville, TN. USDA Forest Service, Southeastern Forest Experiment Station. Gen. Tech. Report SE-69.
- Drews, M.J.; Frederickson, T.S. 2013. The effect of experimental prescribed fire on white pine regeneration. The Open Forest Science Journal. 6: 31-35.
- Elliott, K.J.; Hendrick, R.L.; Major, A.E.; Vose, J.M; Swank, W.T. 1999. Vegetation dynamics after a prescribed fire in the southern Appalachians. Forest Ecology and Management. 114(2): 199-213.
- Elliot, K.J., Vose, J.M., and R.L. Hendrick. 2009. Long-Term Effects of High Intensity Prescribed Fire on Vegetation Dynamics in the Wine Spring Creek Watershed, Western North Carolina, USA. Fire Ecology Vol. 5(2):66-85.
- Evans, C.W., D.J. Moorhead, C.T. Bargeron, and G.K. Douce. 2006. Invasive Plant Responses to Silvicultural Practices in the South. The University of Georgia Bugwood Network, Tifton GA, BW-2006-03. 52 p.
- Frost, C. 1998. Presettlement Fire Frequency Regimes of the United States: A First Approximation. In Pruden, T.L. and Brennan, L.A (eds) Fire In Ecosystem Management: Shifting the Paradigm from Suppression to Prescription. Tall Timbers Fire Ecol. Conf. Proc. Tall Timbers Research Station, Tallahassee, FL.
- Harmon, M. 1982. Fire History of the Westernmost Portion of Great Smoky Mountains National Park. Bulletin of the Torrey Botanical Club. Vol. 109(1):74-79.
- Hicks, R.R. 1998. Ecology and Management of Central hardwood Forests. New York: John Wiley, PP 148-149, 191-199, 199-212, 219-221.
- Iverson, L.R.; Hutchinson, T.F.; Prasad, A.M.; Peters, M.P. 2008. Thinning, fire, and oak regeneration across a heterogeneous landscape in the eastern US: 7-Year Results. Forest Ecology and Management. 255: 3035-3050.
- Johnson, P.S., S.R. Shifley, and R. Roberts. 2009. The Ecology and Silviculture of Oaks, 2nd ed. Massachusetts: CABI, PP 151-159, 196-197, 280-305, 315-329, 329-350, 399.
- Keeley, J.E., Aplet, G.H., Christensen N.L., Conard, S.G., Johnson, E.A., Omi, P.N., Peterson, D.L., and T.W. Swetnam. 2009. Ecological Foundations for Fire Management in North American Forest and Shrubland Ecosystems. USDA Forest Service General Technical Report, Pacific Northwest Research Station. PNW-GTR-779. 93 pages.
- Lynch, J.A. and J.S. Clark. 2002. Fire and Vegetation Histories in the Southern Appalachian Mountains: The historical Importance of Fire Before and After European/American Settlement. A Report Submitted to The George Washington and Jefferson National Forest. Roanoke, Virginia.
- National Archives and Records Administration. 2001. Federal Register. 66 FR 751: 751-777.
- NatureServe. 2002. Notes on Shortleaf Pine Ecosystems and Restoration Efforts in the Southern Appalachians. Prepared for the USDA Forest Service, Cherokee National Forest. NatureServe, Durham, NC.
- NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: April 5, 2019).

- Nyland, R.D. 2002. Silviculture: Concepts and Applications, 2nd ed. New York: McGraw Hill, PP 87-116, 159-172, 227-312, 318-338, 393-406, 508-516.
- Pistrang, M.J. 2019. An Analysis of the Effects of Prescribed Fire During Dormant and Growing Seasons on Plant Species of Viability Concern Within Selected Habitats on the Cherokee National Forest. Unpublished Specialist Report, on file at the Cherokee National Forest.
- SAMAB. 1996. The Southern Appalachian Assessment Terrestrial Technical Report. Report 5 of 5. Atlanta: U.S. Department of Agriculture, Forest Service, Southern region.
- Smith, D.M., B.C. Larson, M.J. Kelty, and P.M.S. Ashton. 1997. The Practice of Silviculture, 9th ed. New York: John Wiley, PP 47-68, 121, 131-157, 195-233, 301-328, 324-326.
- Stanturf, J.A., Wade, D.D., Waldrop, T.A., Kennard, D.K., and G.L. Achtemeier. 2002. Fire in Southern Forest Landscapes. Pages 607-630 in: Wear, D.M. and J. Greis (eds). Southern Forest Resource Assessment. Gen. Tech. Report SRS-53. USDA Forest Service, Southern Research Station. Asheville, NC.
- USDA Forest Service. 2000. Wildland Fire in Ecosystems: Effects of Fire on Flora. General Tech. Rep. RMRS-GTR-42 Vol 2. Rocky Mountain Research Station. Fort Collins, CO.
- USDA Forest Service. 2001. Chapter 2 (TERRA-2): The History of Native Plant Communities in the South. In: Wear, D.M. and J. Greis (eds). Southern Forest Resource Assessment. Gen. Tech. Report SRS-53. USDA Forest Service, Southern Research Station. Asheville, NC.
- USDA Forest Service. 2008. Environmental Assessment Non-Native Invasive Plant Control. Cherokee National Forest, Tennessee.
- USDA Forest Service, 2008b. Wildland Fire in Ecosystems: Fire and Non-native Invasive Plants. General Tech. Rep. RMRS-GTR-42 Vol 6. Rocky Mountain Research Station. Fort Collins, CO.
- USDA Forest Service. 2012. Introduction to Prescribed Fire in Southern Ecosystems. Southern Research Station, Asheville NC. Science Update: SRS-054.
- USDA Forest Service. 2013. The Southern Forest Futures Project. General Technical Report SRS-178. Asheville, NC. Chapter 15 pages 397-456.
- Vose, J. 2004. Degraded Pine Ecosystems in the Southern Appalachians: Causes, Consequences, and Remedies. Power Point Presentation made at the Southern Appalachian Man and the Biosphere conference entitled "After the Southern Pine Beetle" held January 21 and 22, 2004. Murphy, NC.
- Waldrop, T.A.; White, D.L.; Jones, S.M. 1992. Fire regimes for pine-grassland communities in the southeastern United States. Forest Ecology and Management. 47: 195-210.
- Waldrop, T.A.; Yaussy, D.A.; Phillips, R.J.; Hutchinson, T.F.; Brudnak, L.; Boerner, R.E.J. 2008. Fuel reduction treatments affect stand structure of hardwood forests in western North Carolina and southern Ohio, USA. Forest Ecology and Management. 255: 3117-3129.
- Waldrop, T.A.; Phillips, R.J.; Simon, D.M. 2010. Fuels and predicted fire behavior in the southern Appalachian mountains after fire and fire surrogate treatments. Forest Science. 56: 32-45.
- Yaussy, D.A.; Waldrop, T.A. 2010. Delayed mortality of eastern hardwoods after prescribed fire. In: Stanturf, John A., ed. 2010. Proceedings of the 14th biennial southern silvicultural research

conference. Gen. Tech. Rep. SRS-121. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 609-612.

Water

- Beard, T., 2019. Restoration of Dry Forest Communities on the South Zone of the Cherokee National Forest, Soil Resource Report. Chattahoochee-Oconee National Forest Supervisor's Office.
- Burgoyne, T. and Mondry, Z. 2018. Soil Disturbance Monitoring Report. 15p.
- Elliot K.J., and Vose, J.M., 2006, Fire Effects on Water Quality: A Synthesis of Response Regulating Factors Among Contrasting Ecosystems. Coweeta Hydrologic Laboratory, Southern Research Station, USDA Forest Service, 3160 Coweeta Lab Rd, Otto, NC 28763.
- Grove, M., 2019. Restoration of Dry Forest Communities on the South Zone of the Cherokee National Forest, Aquatics Report. Cherokee National Forest Supervisor's Office.
- Hermandorfer, C. 2017. Soil Disturbance Monitoring Report. 8p.
- Jones, D. 2017a. 2016 Forestry Best Management Practices Monitoring, USDA Forest Service, Cherokee National Forest. 155p.
- Jones, D. 2017b. 2017 Forestry Best Management Practices Monitoring, USDA Forest Service, Cherokee National Forest. 121p.
- Jones, D. 2018. 2018 Forestry Best Management Practices Monitoring, USDA Forest Service, Cherokee National Forest. 117p.
- Jones, D. 2019. 2019 Forestry Best Management Practices Monitoring, USDA Forest Service, Cherokee National Forest.
- Mallipudi, N. M., S. J. Stout, A. R. daCunha, and A. Lee. 1991. Photolysis of imazapyr (AC 243997) herbicide in aqueous media. J. Agric. Food Chem. 39(2):412-417.
- Maxwell, J.R.; Neary, D.G. 1991. Vegetation management effects on sediment yields. pp. 12-55 to 12-63, IN: T. Shou-Shou and K. Yung-Huang (eds.) Proceedings of the 5th Federal Interagency Sediment Conference, Vol. 2. March 18-21, 1991, Las Vegas, NV, Federal Energy Regulatory Commission, Washington, D.C.
- Mondry, Z., 2016. Rock Mountain Fire Burned Area Emergency Response (BAER) Hydrology Report. USFS Enterprise Program, Southern Research Station, Research Triangle Park, NC.
- Neary, D.G.; Michael, J.L. 1996. Herbicides protecting long-term sustainability and water quality in forest ecosystems. New Zealand Journal of Forestry Science 26:241-264.
- Reddington, A. and Jones, D. 2015. 2015 Forestry Best Management Practices Monitoring, USDA Forest Service, Cherokee National Forest. 49p.
- Syracuse Environmental Research Associates (SERA), Inc. 2003a. Glyphosate–Human Health and Ecological Risk Assessment Final Report. Task No. 9. SERA TR 02-43-09-04a.
- Syracuse Environmental Research Associates (SERA), Inc. 2003b. Triclopyr–Revised Human Health and Ecological Risk Assessment Final Report. Task No. 13. SERA TR 02-43-13-03b
- Syracuse Environmental Research Associates (SERA), Inc. 2004. Imazapyr (Arsenal, Chopper, and Stalker Formulations) Final Report. Task No. 14. SERA TR 98-21-14-01b.

- Tennessee Department of Agriculture, Division of Forestry (TDF). 2003. Guide to Forestry Best Management Practices.
- Tennessee Department of Environment and Conservation (TDEC). 2013b. Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-4, Use Classifications for Surface Waters. Effective Date July 2, 2013. 38p. (http://www.tn.gov/sos/rules/1200/1200-04/1200-04-04.20130702.pdf.)
- USDA Forest Service, 2016. Fiscal Year 2015 Monitoring and Evaluation Annual Report for the Revised Land and Resource Management Plan, Cherokee National Forest. p.101. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd520242.pdf

APPENDIX 1: Dry Forest Community Descriptions

These community descriptions are taken directly from the Cherokee National Forest South Zone Collaborative Restoration Recommendations for the Management of Off-Site Pine in Dry Forest Communities. (Nature Conservancy 2018)

The following descriptions of the focal dry forest communities are taken from Steve Simon's report entitled: "Ecological Zones on the Chattahoochee and Cherokee-(south) National Forests: 1st Approximation", which in turn was taken from NatureServe. 2013. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S. Data current as of 12 July 2013', and the 'Guide to the Natural Communities of North Carolina, Fourth Approximation (Schafale 2012), unless otherwise noted.

Shortleaf Pine-Oak Forest

This zone includes dry to dry-mesic pine-oak forests dominated by shortleaf pine and/or pitch pine that occur at lower elevations on exposed broad ridges and sideslopes. Indicator species and species with high constancy or abundance include: shortleaf pine, pitch pine, sourwood, sand hickory, scarlet oak, southern red oak, post oak, hillside blueberry, American holly, featherbells, black huckleberry, and spring iris. Ecological Zones within the Chattahoochee and Cherokee (south zone) National Forests include 3 subtypes (aggregated in the final model):

- * map unit 161 = south to west facing steep slopes that are likely driven by stand-replacement fire,
- * map unit 162 = mid to lower elevation tertiary ridges where surface fire is more common than stand replacement fire, and
- * map unit 163 = lower elevation primary ridges where surface fire is more common than stand replacement fire.
 - BpS / Nature Serve --Southern Appalachian Low-Elevation Pine: This system consists of shortleaf pine-and Virginia pine-dominated forests in the lower elevation Southern Appalachians and adjacent Piedmont and Cumberland Plateau.
 Examples can occur on a variety of topographic and landscape positions, including ridgetops, upper and midslopes, as well as low elevation mountain valleys in the Southern Appalachians.
 Under current conditions, stands are dominated by shortleaf pine and Virginia pine. Pitch pine may sometimes be present and hardwoods are sometimes abundant, especially dry-site oaks such as southern red oak, chestnut oak, scarlet oak, but also pignut hickory, red maple, and others.
 The shrub layer may be well-developed, with hillside blueberry, black huckleberry, or other acid-tolerant species most characteristic. Herbs are usually sparse but may include narrowleaf silkgrass and goat's rue.

Pine-Oak Heath Woodland

This zone was included in the Xeric Pine-Oak Heath-Oak Heath type in the 1st approximation NC but separated into three pine-oak heath types in the VA_WVA FLN and GW study areas. This differentiation was not made in the SBR study area. Indicator species and species with high constancy or abundance in all three types include: Table Mountain pine, scarlet oak, chestnut oak, pitch pine, black huckleberry, mountain laurel, and hillside blueberry. Ecological Zones within the Chattahoochee and Cherokee (south zone) National Forests include 4 subtypes (aggregated in the final model:

- * map units 181 and 182 = tertiary and primary ridges with Pitch Pine as the diagnostic fire-adapted species (this Zone resembles the Pine-Oak Heath [Eastside] Zone identified on the GW National Forest that includes landscapes located on the east side of major ridges where patch sizes are smaller, pitch pine is more common, and huckleberry and blueberry is normally more abundant than mountain laurel). These subtypes are likely driven by mixed-stand replacement and surface fire disturbances.

 * map units 183 and 184 = tertiary and primary ridge with Table Mountain Pine as the diagnostic fire-adapted species. These subtypes are likely driven primarily by stand-replacement fire disturbance.
 - Bps / Nature Serve –Southern Appalachian Montane Pine Forest: This system consists of
 predominantly evergreen woodland (or more rarely forests) occupying very exposed, convex,
 often rocky south-and west-facing slopes, ridge spurs, crests, and cliff-tops. Most examples are
 dominated by Table Mountain pine, often with Pitch pine and / or Virginia pine and occasionally
 Carolina hemlock. Based on the component Associations, understories commonly include
 mountain laurel, black huckleberry, and hillside blueberry.



Photo Credit: Steve Simon

Dry-Mesic Oak-Hickory Forest

This zone was included in the Dry and Dry-Mesic Oak-Hickory type in the 1st approximation NC but separated into its components --Dry Oak and Dry-Mesic Oak in the 2nd–3rd approximations, in the KY FLN (Simon 2009), and in the VA_WVA FLN study areas (Simon 2010). This zone is very similar to the Montane Oak-Hickory zone but occurs at lower elevations. It includes dry-mesic, mixed-oak forests that occur along broad lower to mid elevation ridges and smooth to concave slopes and lower elevation drainage headlands, and often narrow, drier coves. Indicator species and species with high constancy or abundance include: white oak, black oak, scarlet oak, flowering dogwood, sourwood, low bush blueberry, and huckleberries.

BpS / Nature Serve --Southern Appalachian Oak Forest: This system consists of predominantly
dry-mesic (to dry) forests occurring on open and exposed topography at lower to mid elevations.
Characteristic species include chestnut oak, white oak, red oak, black oak, scarlet oak, with
varying amounts of hickories, blackgum, and red maple. Some areas (usually on drier sites) now

have dense evergreen ericaceous shrub layers. Northward this system grades into Northeastern Interior Dry-Mesic Oak Forest type.



Photo Credit: Steve Simon

Dry Oak Heath Forest and Woodland (Evergreen and Deciduous)/Chestnut Oak Heath

This zone, called Chestnut Oak Heath in the 1st approximation NC, includes xeric to dry mixed-oak forests typically dominated by an ericaceous (evergreen or deciduous) understory and represents the driest zone where oaks are the dominant species. In general, in the study area, the Dry Oak/deciduous heath zone is more transitional to the Dry-Mesic Oak Ecological Zone and the Dry Oak/evergreen heath zone is more transitional to the Pine-Oak Heath Ecological Zone, however, this varies considerably according to slope position. Further work is needed to differentiate these two zones to separate what is truly an environmental influence and what may be an influence of current fire return interval. Indicator species and species with high constancy or abundance include: chestnut oak, scarlet oak, northern red oak, mountain laurel (in the evergreen heath type), black huckleberry & hillside blueberry (in the deciduous type), red maple, great rhododendron, and sourwood.

• BpS / Nature Serve --Allegheny-Cumberland Dry Oak Forest and Woodland:
These forests were typically dominated by White oak, Black oak, Chestnut oak, and Scarlet oak with lesser amounts of Red maple, Pignut hickory, and Mockernut Hickory. These occur in a variety of situations, most likely on nutrient-poor or acidic soils and, to a much lesser extent, on circumneutral soils. American chestnut was once dominant or codominant in many of these forests and sprouts of American chestnut can often be found where it was formerly a common tree. Small inclusions of Shortleaf pine and/or Virginia Pine may occur, particularly adjacent to escarpments or following fire. In the absence of fire, White pine may invade some stands (Nature Serve 2010). Today, subcanopies and shrub layers are usually well-developed. Some areas (usually on drier sites) now have dense evergreen ericaceous shrub layers of mountain laurel, fetterbush, or on more mesic sites rhododendron. Other areas have more open conditions.



Photo credit: Steve Simon

APPENDIX 2: Restoration Plan Criteria

To achieve ecological restoration goals, the following guidance will be considered in all restoration decisions:

- 1. Encourage, sustain and restore ecologically appropriate natural processes
- 2. Preserve and promote desired advanced regeneration
- 3. Preserve and promote biodiversity
- 4. Avoid and respond to unintended consequences (i.e. introduction of non-native invasive species and extensive or continuous levels of soil erosion)
- 5. Recognize that restoration is a long-term commitment and that sequential actions and monitoring are essential to success

A full suite of management actions should be considered for any restoration effort and the most effective methods should be used in furtherance of achieving the stated DFC. These include mechanical treatments from clearcutting and herbicide to prescribed fire or wildland fire use for ecological benefit. However, the following primary guidance will be considered in choosing any management tool.

- 1. Species diversity of the future stand should be of paramount importance when conducting any operations. Whenever possible, leave trees should include a full range of the native tree diversity appropriate to the site with the intention of a mixed age or size class stand.
- 2. Soil health is vital to the health of future stands. There should be minimal soil disturbance and coarse woody debris should be left on the forest floor as a contributor to future soil health wherever feasible.

In situations where the site is dominated by off-site pine species, preference should be given to mechanical treatments (thinning or regeneration). It is important to consider the landscape context (adjacency to other activities, inclusion in burn blocks, adjacent to unwanted seed sources, etc.) for each restoration project. The following criteria should be used to prioritize locations for ground based harvesting treatments:

- 1. Slopes </= 35%
- 2. Stands to be treated are within ½ mile of existing FS inventoried roads
- 3. Areas are mapped as dry forests as defined by Simon's Ecological Zones, or have been ground-truthed as such.
- 4. Stands to be treated are contained within or adjacent to a burn unit, or easily included in a burn unit

As a way to guide future restoration projects within dry forest communities and develop site specific prescriptions, the following simple decision tree has been developed.

Is the site dominated by off-site pines in the canopy?

- a. Yes: Consider the use of clearcutting, seed tree, and pre/commercial thinning treatments. These treatments should be used to the degree at which dominant off-site pine has adversely affected the desired future condition and biodiversity of a particular stand. In conjuncture with these harvest treatments, site preparation for planting, site preparation for natural regeneration, plant trees, and tree release and weed maybe needed to help achieve the desired future condition.
- b. No: Go to next line.

Is the site being encroached by off-site pines in the midstory or understory?

- a. Yes: If encroachment is occurring within the midstory and off-site pine has adversely affected the biodiversity of the mid-story, advanced regeneration, and herbaceous layer, consider the use of improvement cuts, prescribed burn, tree release and weed, and/or site preparation for natural regeneration treatments.
- b. Yes: If encroachment is occurring primarily within the understory, consider the use of prescribed fire as the primary management tool. Tree release and weed, and site preparation for planting/natural regeneration will also be used when the understory has a high composition of off-site pine.
- c. No: Site is not a good candidate for restoration under this authority.

APPENDIX 3 - Scenery Treatment Guide - Southern Regional National Forests

Introduction

The objectives of the Scenery Treatment Guide are two-fold: to help managers meet Forest Land and Resource Management Plan direction pertaining to Scenery Integrity Objectives (SIOs) and to determine what treatments should be used to mitigate scenery impacts in applicable prescription areas during environmental analysis of project implementation and sale design.

The Guide is intended to help achieve Scenic Integrity Objectives and desired conditions during project planning. The Guide is not a commitment or final decision that compels action, nor does it approve or prohibit projects and activities. However, once the selected treatments are listed in the approved project-specific NEPA document, they become a requirement for implementing that project.

In the past, Forest Scenery resource managers used forest-specific guidelines to help meet Visual Quality Objectives (VQOs) established through Forest Land and Resource Management Plans. In addition, guidelines were published on a national basis in the *National Forest Landscape Management* handbook series, particularly in volume 2, chapter 5: *Timber*. During development of the Southern Appalachian National Forests' Land and Resource Management Plans, it was determined that there continued to be a need to compile uniform guidance for meeting Scenery Integrity Objectives (SIOs). The Southern Appalachian Recreation Resource and Wilderness Analysis Group (SARRWAG) RLRMP revision team compiled the Scenery Treatment Guide to ensure that the SIOs in the new Forest Plan Revisions are successfully met and to act as proactive measure to enhance our outstanding forest landscapes.

The Guide offers a listing of management activities and various treatment clauses that may be used to meet the RLRMP management direction for SIOs. The listing of Management Treatments and Management Activities is not all-inclusive. It is also not to be used as a cookie cutter for automatically determining which treatments should be applied. Each project may have unique conditions that would need to be considered. All treatments may not apply.

This guide is dynamic; it will evolve as managers continue to learn from the results of applying these treatments. New practices affecting forest scenery may emerge, and as they do, new treatments to mitigate their effects are expected to be added to the guide.

The first draft of the Region's Scenery Treatment Guide was initiated on the George Washington and Jefferson National Forests by an interdisciplinary team that included Ranger District and Supervisor's Office personnel. It also borrowed from previous work done over the years by the Kisatchie National Forest, George Washington and Jefferson National Forests, and others. Initial drafts were reviewed, as well, by Regional Office timber, wildlife and recreation staff personnel. The final guide has been reviewed by all Forests and Regional Office Resource and Planning Staffs.

Specific SIO direction for Very High has not been included in this Guide because it is felt that treatments for these significant landscapes must be developed with the advice of the Forest Landscape Architect at the time of project analysis. It is also believed that all treatments apply to all Physiographic Sections and Landscape Character Themes. No specific direction was developed for "Forest Health" management, with the assumption that various listed treatments can be applied on a case-by-case basis.

Techniques to Achieve Scenic Integrity Objectives and Landscape Character in Southern Region National Forests

Topic or Management Activity	Scenery Treatments by Scenic Integrity Objective (SIO)						
Management Activities	Very High	High	Moderate	Low			
Clearcutting		*	B, D, E, G, H, I, L, O, P, T, V, W, AA	N, T, V, W, AA			
Commercial/Non-Commercial thinning Coppice with	Consult landscape architect for	A, B, C, D, E, F, G, H, I, S, T, V, W, Y, AA	B, D, E, G, H, I, S, T, V, W, AA B, D, E, G, I, M, O, P,	B, T, V, W, AA			
Coppice with reserves	any projects in	,	S, T, V, W, AA	B, N, S, T, V, W, AA			
Create Field Successional Variety and Open Areas	areas with Very High	A, B, C, D, E, F, G, H, I, L, O, P, S, T, U, V, W, Z	B, D, G, H, I, L, O, P, S, T, U, V, W, Z	B, N, S, T, V, W			
Create Openings for Viewing Wildlife	SIOs	A, B, E, F, G, M, S, T, V, W, Z	B, E, G, S, T, V, W, Z	B, T, V, W			
Create Parklike/ Savannah Effect in Forest Stands		A, B, C, D, E, F, G, H, I, S, T, U, V, W, X, Y, AA	B, D, E, G, H, I, S, T, U, V, W, AA	T, V, W, AA			
Create/Enhance Scenic Environment in Developed Recreation Sites		A, B, D, E, F, G, H, R, S, T, U, V, W, X, Y, Z	B, D, E, F, G, H, R, S, T, U, V, W, X, Y, Z	* Receation Areas normally not applicable to this SIO			
Create/Maintain Wildlife Habitat, Restore PETS and Native Commmunities		B, D, E, G, H, I, K (creating), M(restoring), N(maintaining), T, V, W, AA	B, D, E, G, H, I, N, T, V, W, AA	B, D, H, T, V, W, AA			
Create Spatial Diversity/Variable Density Vegetation		A, B, C, D, E, F, G, H, I, J, O, S, T, V, W, Y, Z, AA	B, C, D, E, F, G, I, L, M, O, P, R, S, T, U, V, W, Y, AA	N, S, T, V, W, AA			
Create Vistas		A, B, D, E, F, G, H, T, U, V, W, X	B, D, E, F, G, U, V, T, W, X	B, T, V, W			
Create Visual Mosaic of Vegetation Along Travelways and Watercourses		A, B, C, D, E, F, G, H, I, J, Q, S, T, U, V, W, Z, AA	B, C, D, E, F, G, H, I, L, Q, S, T, U, V, W, Z, AA	B, E, G, N, S, T, V, W, AA			
Decrease Visual Impacts of Utility Corridors		* Utility corridors normally not applicable to this SIO B, C, D, E, F, Q, R, S, T, U, V, W	B, C, D, E, F, Q, R, S, T, U, V, W	E, Q, R, S, T, U, V, W			

Topic or Management Activity	Scenery Treatments by Scenic Integrity Objective (SIO)						
Management Activities	Very High	High	Moderate	Low			
Group Selection		A, B, C, D, E, F, G, H, I, J, T, U, V, W, AA	B, D, E, G, H, I, K, T, U, V, W, AA	B, K, T, U, V, W, AA			
Overstory Removal Seed-Tree Removal/ Shelterwood Removal		B, C, D, E, F, G, H, I, O, P, Q, S, T, V, W, AA	B, D, G, H, I, O, P, Q, S, T, V, W, AA	Q, S, T, V, W,AA			
Permanent Road Construction/Reconst.	Consult	B, C, D, E, F, G, H, I, Q, R, S, T, U, V, W	B, C, D, E, G, H, I, Q, R, S, T, U, V,W	Q, R, S, T, U, V, W			
Prescribed Burn	landscape	D, E, F, H	D, E, H	Н			
Reduce Visibility of Communication/ Electronic/Utility Tower Structures and Corridors	architect for any projects in areas	* A, B, C, D, F, G, H, I, R, S, T, U, V, W	B, C, D, E, F, H, I, R, S, T, V W	B, E, I, S, T, R, V, W			
Roadside Maintenance	with Very High	B, F, G, H, T, U, V, W, X, Z	B, F, G, T, U, W	T, U, V, W			
Salvage	SIOs	B, C, D, E, F, G, H, I, T, V, W, AA	B, D, E, G, I, T, V, W, AA	B, T, V, W, AA			
Seed-Tree		*	B, D, E, G, I, M, O, P, Q, T, V, W, AA	B, N, Q, T, V, W, AA			
Shelterwood		*	B, D, E, G, I, M, O, P, Q, T, V, W, AA	B, N, Q, T, V, W, AA			
Shelterwood (w/reserves)		*	B, D, E, G, I, M, O, P, Q, T, V, W, AA	B, N, Q, T, V, W, AA			
Single-Tree Selection		A, B, C, D, E, F, G, H, I, T, U, V, W, AA	B, D, E, G, H, I, T, U, V, W, AA	B, T, U, V, W, AA			
Temporary Road/Skid Trail Construction		B, C, E, G, H, I, T, U, W, AA	B, E, G, H, I, T, U, W, AA	B, T, U, W, AA			
Two-aged Harvest		*	B, D, E, G, I, M, O, P, T, V, W, AA	B, N, V, T, W, AA			
Trails Construction. Rehabilitation, Reconstruction		A, B, D, E, F, H, Q, S, V, W, Z, AA	B, D, E, F, H, Q, S, V, W, Z, AA	B, D, E, F, H, Q, V, W, AA			

^{*} Not always appropriate in areas with this SIO. Consult landscape architect.

List of Treatment Clauses

- d. Trees should be selectively removed to improve scenery within high use areas, vista points, and along interpretive trails.
- e. Flowering and other visually attractive trees and understory shrubs should be favored when leaving vegetation.
- f. During temporary or permanent road construction, slash and root wads should be eliminated or removed from view in the immediate foreground to the extent possible. Slash may be aligned parallel to roads at the base of fill slopes to collect silt, but usually only if it provides this function.
- g. Slash should be removed, burned, chipped or lopped to within an average of 2 feet of ground, when visible within 100 feet on either side of Concern Level 1 travel routes. Slash should be treated to within an average of 4 feet of the ground when visible within 100 feet on either side of Concern Level 2 travel routes. Removal of all slash or other special slash treatments may be considered for certain Concern Level 1 travel routes or trails where the SIO is Very High or High.
- h. Root wads and other unnecessary debris should be removed or placed out of sight within 150 feet of key viewing points.
- i. Stems should be cut to within 6 inches of the ground in the immediate foreground.
- j. Leave tree marking or unit boundary marking should be applied so as to not be visible within 100 feet of Concern Level 1 and 2 travel routes.
- k. Consider scheduling work outside of major recreation seasons.
- 1. Special road and landing design should be used. When possible, log landings, roads and bladed skid trails should be located out of view to avoid bare mineral soil observation from Concern Level 1 and 2 travel routes.
- m. An actual opening size of up to 1.5 2 acres may be appropriate, based on desired landscape character.
- n. An actual opening size of up to 5 acres may be appropriate, based on desired landscape character.
- o. An actual opening size of up to 10 acres maybe appropriate in the foreground zone and up to 25 acres in middleground and background zones in Concern Level 1 and 2 travel routes.
- p. An actual opening size of up to 25 acres with inclusions may be appropriate.
- q. An actual opening size of up to 40 acres with inclusions may be appropriate. Larger openings may occur in certain forest types based on specific Forest Plan direction.
- r. Along Concern Level 1 and 2 travel routes, harvest units (or openings) in contiguous woodland should be spaced no closer than 1000 feet apart next to the travelway.
- s. Along Concern Level 1 travel routes, openings of up to 200 linear feet may be appropriate. Along Concern Level 2 travel routes, openings of up to 400 linear feet may be appropriate.
- t. Removal of overstory should be delayed until understory is approximately one-third the height of the adjacent stand.

- u. Utility rights-of-ways should be located and maintained to conform with natural-appearing patterns of vegetation to the extent possible.
- v. Overhead utility lines and support towers should be screened where possible. Structures should have finishes that reduce contrast with the desired landscape character.
- w. The visual impact of roads and constructed fire lines should be blended so that they remain subordinate to the existing landscape character in size, form, line, color, and texture.
- x. Gravel pits, borrow areas, open pit mines and restored gullies should be excluded from the seen area of visually sensitive travelways and viewing points to the extent possible.
- y. Openings and stand boundaries should be organically shaped. Straight lines and geometric should be avoided. Edges should be shaped and/or feathered where appropriate to avoid a shadowing effect in the cut unit. Openings should be oriented to contours and existing vegetation patterns to blend with existing landscape characteristics, as appropriate.
- z. Cut and fill slopes should be revegetated to the extent possible. In seen areas, consider seasonal color of vegetation. For instance, using warm season grass mixes that turn seasonally brown or gray instead of green. Cut banks should be sloped to accommodate natural revegetation.
- aa. Mowing or bush hogging should be accomplished prior to herbicide treatment.
- bb. A range of stem diameters should be provided but 14 inch and larger stems in a mixture with other smaller sized tree stems should be favored.
- cc. Native wildflowers and/or shrubs and/or trees with showy flowers and/or fruits should be favored or introduced.
- dd. Impacts to forest trails should be minimized. Trail-related mitigations can include all or portions of the following: Temporary road and/or skid trail crossings across designated forest trails should be kept to a minimum. Any crossings should be perpendicular to designated forest trails. Using segments of designated forest trails as skid trails/haul roads should be avoided, as much as possible. If trails are used as skid trails/haul roads, specify trail cleanup/rehabilitation should be specified at the end of the contract. Trail width should not be increased. Character trees and trees that define the trail corridor should be retained. Changes to trail alignment and surfacing should be minimized; the trail should not be straightened nor should its surface be changed with an alternate material unless such actions are needed to enhance the trail and protect resources. Warning signs should be placed on all trail access points and along the trail where activities are occurring. When activities are occurring along open trails, slash should be treated within 100' of the corridor, either daily or another agreed on time period (check with recreation specialist). If trails are temporarily closed due to harvesting, trail tread should be cleared of all slash prior to reopening that section for public use. Slash should be treated to an average of 4 feet from the ground within 100' of the corridor prior to finalizing harvesting activities in the affected unit.